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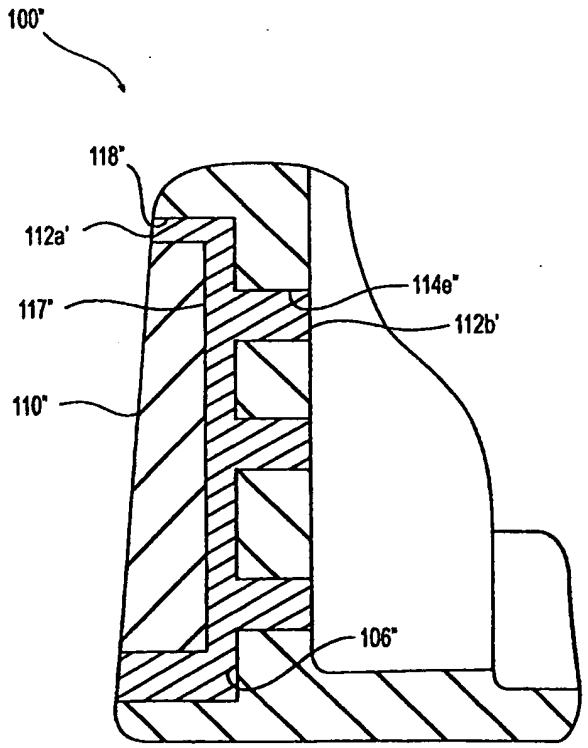
(54) Title: GOLF CLUB HEAD WITH AN INSERT ON THE STRIKING SURFACE

(57) Abstract

A golf club head (100") has a strike face and an opposite back face portion. The strike face defines a recess. An insert (110") is disposed within the recess. Vibration dampening material (112a', 112b') is disposed between the insert (110") and the recess.



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GOLF CLUB HEAD WITH AN INSERT ON THE STRIKING SURFACE

This application is a continuation-in-part of co-pending Application No. 09/220,083, filed December 23, 1998 and a continuation-in-part of copending Application No. 08/711,337, filed September 6, 1996, the disclosure of which are incorporated by reference in their entirety.

TECHNICAL FIELD

The present invention relates to golf clubs and, more particularly, to a golf club that has an insert on the strike surface of the club.

BACKGROUND OF THE INVENTION

Golf clubs have long been developed to improve the "touch and feel" of the club, most particularly with, but not limited to, the clubs used on and around the green. One approach to improve the touch and feel of a club is to modify either the grip, the shaft, or the strike face of the golf club. For example, modifications to the club head could include an insert that is placed on the club strike surface to affect the impact of the club with the golf ball and to improve the feedback to the golfer after impact.

It is desired that the present invention provided an improved golf club head with better touch and feel as a result of modifying the strike face of the golf club head.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a golf club with an improved "touch and feel" on and around the green.

Another object of the present invention is to provide a golf club with an insert on the strike face that affects the rebound of the golf ball at impact with the strike face.

Another object of the present invention is to provide a golf club that dampens vibrations and improves the feedback to the golfer at impact of the golf club with the golf ball.

According to the present invention, a golf club includes a strike surface and an opposite back face portion. The strike face includes a recess with a bottom surface and a side wall surface. The club head further includes an insert which is disposed in the recess. The insert has a peripheral outer edge that is spaced from the side wall surface to define a peripheral groove. A vibration dampening material is disposed within the groove to vary the feel of the club.

According to one embodiment, the insert further includes a first portion and a second portion, where the first portion extends radially outwardly from the second portion. When the insert is within the recess, the first portion contacts a portion of the side walls and the second portion includes the peripheral edge.

In another embodiment, the club head further includes a back face portion opposite the strike face and a plurality of apertures that extend into the back face portion of the club head toward the insert. At least one of the apertures is filled with a vibration dampening material.

In yet another embodiment, the insert is modified so that the vibration dampening material in the groove communicates and is continuous with the vibration dampening material in the apertures. In another embodiment, the vibration dampening material extends through the insert.

According to a separate embodiment of the invention, a golf club includes a strike surface and an opposite back face portion. A metal insert is located on and is positioned flush with the strike surface. A plurality of apertures extend into the back face portion of the club head toward the insert. At least one of the apertures is filled with a

vibration dampening means, where the insert and the vibration dampening means are of different materials.

According to another embodiment of the present invention, a golf club includes a strike surface and an opposite back face portion. The strike face includes a recess with a bottom surface and a side wall surface. The club head further includes an insert which is disposed in the recess. The insert has a first portion, a second portion, and a back face. The first portion includes a front surface spaced from the strike face, and a first passageway extending from the upper surface to the back face of the insert. The second portion forms a portion of the strike face. A vibration dampening material is located in the first passageway.

The configuration of the insert and club head vary the amount of vibration dampening material within the club to vary the feel of the club.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front perspective view of a golf club head of the present invention showing an insert located on a strike face.

Fig. 2 is a rear view of the golf club head of the present invention showing a plurality of apertures spaced apart on a back face of a club head.

Fig. 3 is a cross-sectional view taken from line 3-3 of Fig. 2 showing the apertures filled with an elastomeric material.

Fig. 4 is a cross-sectional view taken from line 4-4 of Fig. 2 showing fasteners extending through the back face and into the insert.

Fig. 5 is an exploded front perspective view of the golf club of the present invention showing the club head before assembly.

Fig. 6 is a cross-sectional view similar to Fig. 3 showing the insert positioned in the strike face side of the club head before the final machining operation.

Fig. 7 is a cross-sectional view similar to Fig. 3 showing a separate embodiment of the golf club head of the present invention.

Fig. 8 is a cross-sectional view similar to Fig. 3 showing a separate embodiment of the golf club head of the present invention.

Fig. 9 is an exploded front perspective view of the embodiment shown in Fig. 8 showing the golf club head before assembly.

Fig. 10 is a cross-sectional view similar to Fig. 3 showing a separate embodiment of the golf club head of the present invention.

Fig. 11 is an exploded front perspective view of the embodiment shown in Fig. 10 showing the golf club head before assembly.

Fig. 12 is an elevational view taken from line 12-12 of Fig. 11 showing the back face of the insert.

Fig. 13 is a view taken from line 13-13 of Fig. 10 showing the club head back face with the elastomeric material and the fasteners removed.

Fig. 14 is a cross-sectional view similar to Fig. 3 showing a separate embodiment of the golf club head of the present invention.

Fig. 15 is a cross-sectional view similar to Fig. 3 showing a separate embodiment of the golf club head of the present invention.

Fig. 16 is a cross-sectional view similar to Fig. 6 showing the insert positioned in the strike face side of the club head before the final machining operation.

Fig. 17 is a front perspective view of a separate embodiment of a golf club head of the present invention

showing an insert located on a strike face of an iron-type club.

Fig. 18 is a rear view of the golf club head shown in Fig. 17 showing a plurality of apertures spaced apart on a back face of a club head.

Fig. 19 is a cross-sectional view taken from line 19-19 of Fig. 18 showing the apertures filled with an elastomeric material.

Fig. 20 is a front perspective view of another embodiment of the golf club head of the present invention showing the insert located on a strike face with an elastomeric material there around.

Fig. 21 is an exploded front perspective view of the golf club head of Fig. 20 before assembly.

Fig. 22 is a cross-sectional view taken along line 22-22 of Fig. 20 showing a space and apertures filled with an elastomeric material.

Fig. 23 is a cross-sectional view similar to Fig. 22 wherein the insert defines a gap, a space, and apertures filled in an elastromeric material.

Figs. 24 is an enlarged perspective view of another embodiment of the insert for use with the club head shown in Figs. 20 and 21.

Fig. 25 is a cross-sectional view along the line 25-25 of Fig. 24 showing the insert of Fig. 24 assembled in a club head.

Fig. 26 is an enlarged perspective view of another embodiment of the insert for use with the club head shown in Figs. 20 and 21.

Fig. 26a is a front perspective view of an alternative embodiment of a golf club head of the present invention showing the insert located on the strike face and a vibration dampening material there around.

Fig. 27 is a rear view of the golf club head of Fig. 26a showing a plurality of apertures spaced apart on a back face of a club head with the vibration dampening material within the apertures.

Fig. 28 is an exploded front perspective view of the golf club head shown in Fig. 26a with the insert shown in Fig. 26, wherein the club head is not assembled.

Fig. 29 is a front view of the club head of Fig. 28, showing the club head after assembly but prior to injecting the vibration dampening material therein.

Fig. 29A is an enlarged partial front view of the portion of the club head within the circle 29A of Fig. 29.

Fig. 30 is a cross-sectional view taken from line 30-30 of Fig. 29 showing the golf club head with the vibration dampening material therein.

Fig. 31 is an enlarged, front perspective view of another embodiment of the insert for use with the club head of the present invention.

Fig. 32 is a front view of the insert of Fig. 31, within the club head after assembly but prior to injecting the vibration dampening material therein.

Fig. 31A is an enlarged, front perspective view of another embodiment of the insert for use with the club head of the present invention.

Fig. 32A is a front view of the insert of Fig. 31A, within the club head after assembly but prior to injecting the vibration dampening material therein.

Fig. 33 is a cross-sectional view taken from line 33-33 of Fig. 32 showing the golf club head with the vibration dampening material therein.

Fig. 34 is an enlarged, front view of a golf club head with the insert removed.

Fig. 34A is an enlarged, front view of another embodiment of the insert for use with the club head shown in Fig. 34.

Fig. 35 is an enlarged, back view of the insert shown in Fig. 34A.

Fig. 36 is a cross-sectional view taken from line 36-36 of Fig. 34A showing the golf club head with the insert of Figs. 34-35 and the vibration dampening material therein.

Fig. 37 is an enlarged, back view of another embodiment of the insert for use with the club head shown in Fig. 34.

Fig. 38 is an enlarged perspective view of another embodiment of the insert for use with the club head shown in Figs. 26a and 27-29.

Fig. 39 is a cross-sectional view along the line 39-39 of Fig. 38 showing the insert of Fig. 38 assembled in a club head and the vibration dampening material therein.

Fig. 40 is a cross-sectional view along the line 40-40 of Fig. 38 showing the insert of Fig. 38 assembled in a club head and the vibration dampening material therein.

Fig. 41 is an enlarged, front perspective view of another embodiment of the insert for use with the club head shown in Figs. 26a and 27-29.

DETAILED DESCRIPTION OF THE INVENTION

According to the present invention and referring to Figs. 1 and 2, a golf club 10 has a shaft 12 (only partially shown) attached to a club head 14. A putter-type club head is shown in Fig. 1, however, as explained below, an iron-type club head may also be utilized with the present invention.

The club head 14 has a hosel 16 that accepts the shaft 12 with a heel 18 at the hosel end of the club head 14 and a toe 20 opposite of the heel 18. The club head 14 also has a sole portion 26 and an opposite top portion 28. Extending between the heel 14 and the toe 20 is a strike face 22, which

is the surface that contacts the golf ball (not shown) upon impact between the golf club 10 and the ball. The strike face 22 includes a "sweet spot," or the center of gravity in the toe to heel direction, which is covered with an insert 24. The insert 24 is made of a material that is different than the rest of the club head. In the preferred embodiment, the insert is made of a tellurium copper alloy, which is a relatively soft alloy that improves the touch and feel of the club. In the preferred embodiment, the tellurium copper alloy includes a minimum of 99.4% copper, a maximum of .004-.012 ppm of phosphorus and a maximum of 0.4-0.7 ppm of tellurium, and has a hardness of approximately 80 HB.

As shown in Fig. 2, the club head 14 has an essentially flat back face portion 36 that extends partially between the heel 18 and the toe 20 and partially between the top portion 28 and the sole portion 26. The back face portion 36 has a plurality of apertures 32 that are preferably evenly spaced apart in relation to each other, that follow the contour of the back face portion 36 and that are essentially perpendicular to the strike face 22.

As shown in Fig. 3, the apertures 32 extend from the back face 36 toward the insert 24. Preferably more than five apertures are used, more preferably there are greater than 20 apertures, and most preferably there are 32 apertures. A vibration dampening means, such as an elastomeric material 34 that is deformable is located in each aperture 32. In the preferred embodiment, which will be described in detail below, the elastomeric material is a silicone material, Stock No. GE281, available from General Electric Company in Waterford, NY.

As shown in Fig. 3, the insert 24 is press fit into a complementary strike face recess 42. The interference fit between the insert 24 and the strike face recess 42 is approximately 0.002 - 0.003 inches. The insert 24 has a back

face 46, which is in contact with and adjacent to a recess bottom surface 44. The contact between the two surfaces creates a metal-to-metal contact between the insert 40 and the recess bottom surface 44. The size of the apertures 32 and the volume of the elastomeric material 34 located in the apertures combine to reduce the amount of metal-to-metal contact between the insert 40 and the recess bottom surface 44. Therefore, the "touch and the feel" of the putter may be altered by varying the amount of metal-to-metal contact and by proportionately varying amount of elastomeric material located in the back face 36.

The insert 24 has a strike face 40 that is essentially axially aligned with the club head strike face 22. The strike faces 22 and 40 have a loft angle θ, which for a standard lofted putter the loft angle is approximately 4 degrees.

Referring now to Figs. 2, 4 and 5, four of the outermost apertures 50a, 50b, 50c and 50d accept a fastening means. In the embodiments described herein, the additional fastening means is four (4) allen head fasteners with a "0" primary size and a Fine UNF thread rating of 80 by 0.250 inches long, which is represented by numerals 58a, 58b, 58c and 58d. The outermost apertures 50a, 50b, 50c and 50d follow the outer contour of the back face 36 and each have a complementary clearance hole 52a, 52b, 52c and 52d and a complementary counterbore 54a, 54b, 54c and 54d (only counterbores 54a and 54b are shown in Fig. 4).

Fig. 5 shows an exploded view of the club head 14 prior to assembly. The insert back face 46 has four threaded holes 56a, 56b, 56c and 56d that are complimentary to the clearance holes 52a, 52b, 52c and 52d. The insert 24 has a flange 68 and is press fit into the insert strike face 42 with an arbor press with the arbor press applying pressure to the flange 68 so that the insert back face 46 is in full contact with the

recess bottom surface 44 after insertion. As shown in Fig. 6, the insert 24 bottoms out against the recess bottom surface 44. The insert 24 is deeper than the depth of the strike face recess 42 so that the insert 24 bottoms out and so that there is a gap 70 between the flange 68 and the club head 14. The four fasteners 58a, 58b, 58c and 58d are then fastened into the insert 24, which further connects the insert 24 into the strike face recess 42. Then during a machining process, the flange 68 is then machined off as the strike surface 22, the insert 24 and the loft of the club are defined. Finally, the elastomeric material 34 is inserted into the apertures 32 and into the outermost apertures 50. A squeegee is scraped across the back face 36 to remove the excess silicone, leaving the silicone in each of the apertures, which also covers the heads of the fasteners so that the fasteners are not visible from the back face 36.

In Fig. 7, the embodiment shown is essentially the same as described above, except that all of the apertures are counterbored. This embodiment reduces the amount of silicone material 34' that is in contact with the insert 24', which in turn affects the touch and feel of the club. The clearance holes 52', as in the above described embodiment, have a diameter of approximately 0.06 - 0.08 inches.

A separate embodiment is shown in Figs. 8-9, which is similar to the above disclosed embodiment shown in Fig. 3, except that the insert 24' has a plurality of insert cavities 72. The insert cavities 72 are aligned to be complementary to the plurality of apertures 32'. This embodiment provides a more pronounced vibration dampening feature than the embodiment disclosed in Fig. 3 since the elastomeric material 34' extends into the insert back face 46'.

Yet another embodiment is shown in Figs. 10-13. Fig. 10 is similar to the cross-sectional view of Fig. 8. This embodiment is similar to the embodiment shown in Figs. 8-9,

except that all of the apertures are counterbored, as disclosed in the embodiment shown in Fig. 7, and that the insert back face 46' has a continuous passageway 74, or a matrix, that connects each of the insert cavities 72'. The passageway is made with a 1/16 inch ball end mill. The continuous passageway 74 provides a more pronounced vibration dampening feature than the embodiment disclosed in Figs. 3 and 8 since the elastomeric material 34' extends into the insert back face 46' and since it encompasses more area on the insert back face 46'.

Fig. 13 shows the club head assembled, but without the fasteners and the silicone material in the apertures, with the passageway 74 being aligned with each of the apertures.

Another embodiment is shown in Fig. 14, which is similar to the embodiment shown in Fig. 3, except that the apertures 32' do not extend into the strike face recess 42'. This embodiment provides a lesser amount of vibration dampening compared to the other above described embodiments.

Yet another embodiment is shown in Figs. 15-16, which is similar to the embodiment described in Fig. 3, except that there is a gap 76 between the insert back face 46' and the strike face recess bottom surface 44'. As shown in Fig. 16, the gap 76 may be predetermined by a flange to insert back face dimension 78, so that when the insert 24' is press fit into the strike face recess 42', the gap dimension is determined. A second vibration dampening means, such as foam rubber, may be inserted in the gap 76. In the alternative, the gap 76 is filled with elastomeric material 34'. The flange 68' is then machined off, as described in detail above.

Yet another embodiment is shown in Figs. 17-19, which is similar to the above described embodiment shown in Figs. 10-13, except that the club shown is an iron-type club. In this embodiment, the insert 24' material should be a harder

material, such as titanium, for the low lofted clubs (2-4 irons), a softer material, such as steel, for the medium lofted clubs (5-7 irons), and yet a softer material, such tellurium copper, for the high lofted clubs (8-wedges).

Another embodiment is shown in Figs. 20-22, which is similar to that discussed with respect to Figs. 1-5. The club head 100 has a strike face 102 that defines a recess 104 having a bottom surface 106 and a side wall surface surrounding the bottom surface 106. The side wall surface includes a plurality of portions 107-109. The pair of horizontal side wall portions 107 are substantially parallel to one another, and generally horizontal. The pair of vertical side wall portions 108 are substantially parallel to one another, and generally vertical. The four corner side wall portions 109 extend between adjacent horizontal and vertical side wall portions to form an angled surface.

The recess 104 receives an insert 110 and a first vibration dampening material 112a. The club head 100 further includes a flat back face portion 113, as described with respect to Fig. 2. The back face portion 113 defines a plurality of apertures 114a-f that are preferably evenly spaced apart in relation to each other, that follow the contour of the back face portion 113 and that are essentially perpendicular to the strike face 102. The apertures 114a-f extend from the back face portion 113 to the bottom surface 106 of the recess 104. Preferably more than five apertures are used, more preferably there are greater than 20 apertures, and most preferably there are 32 apertures. The apertures 114a-114d are clearance holes, the aperture 114e is a central aperture, and the remaining apertures are apertures 114f.

Referring to Figs. 21 and 22, the integrally formed insert 110 includes a first portion or flange 115 and a second or platform portion 116. The flange 115 extends

radially outwardly from the platform portion 116. The insert 110 further includes a back face 117.

The flange 115 is sized to fit within the recess. When the insert 110 is inserted in the recess 104, the back face 117 is in contact with the bottom surface 106 of the recess 104. Furthermore, the flange 115 is disposed adjacent and in contact with the bottom wall 106 and the side wall surface poritons 107-109. In the installed position, the platform portion includes the outer peripheral edge which is spaced from at least a portion of the side wall surface to define a peripheral groove 118 between the platform portion 116 and the side wall surface. The flange 115 centers the insert within the recess. The peripheral groove 118 surrounds the platform portion 116 of the insert. The groove 118 has a width, designated by the arrow w in Fig. 29. The width w is preferably about 0.040 inches.

The first vibration dampening material 112a is disposed in the groove 118 around the insert 110. The first vibration dampening material 112a substantially fills the groove 118 and has a front surface 120 which is essentially axially aligned with the club head strike face 102 and the insert strike face 121. The depth of the first vibration dampening material is designated by the arrow D in Fig. 22. The depth can be constant around the insert or varied.

Turning to Fig. 21, the insert back face 117 includes five threaded holes 122a-122e (shown in phantom). The holes 120a-120e are complimentary to the apertures 114a-114e in the club head 100. The five fasteners 124a-124e are fastened into the insert holes 120a-120e. The fasteners 124a-124e connect the insert 110 to the club head. During machining of the loft in the putter, the fasteners aid in maintaining the connection between the insert and the club head. After machining, the center fastener 124e is removed from the insert hole 122e. The purpose of the center fastener 124e is

to aid in maintaining the connection between the insert and the club head during machining.

The second vibration dampening material 112b is disposed in at least one of the apertures 114a-f in the club head 110. More preferably, the second vibration dampening material 112b is disposed in all of the apertures 114a-f.

In the preferred embodiment, the vibration dampening material 112a and 112b is an elastomeric material that is deformable. In the most preferred embodiment, the elastomeric material is a silicon material. One example of a recommended silicon material is commercially available under Stock No. GE281 from General Electric Company in Waterford, NY.

Using the first vibration dampening material 112a on the strike face in addition to the second vibration dampening material 112b in the back face portion provides more pronounced vibration dampening, than the embodiment shown in Fig. 2 since the vibration dampening material 112a and 112b encompasses more area on the insert.

Referring to Fig. 21, in other embodiments the back face 117 of the insert can be modified to accommodate different amounts of the vibration dampening material. For example, as discussed with respect to Figs. 8-9, in one preferred embodiment the back face can include the insert cavities 72. In another embodiment, as discussed with respect to Figs. 10-13, the insert back face can have the continuous passageway 74. Furthermore, the geometry of the apertures 114a-114e can be modified. As shown in Figs. 7 and 10, so that the apertures are counterbored. As shown in Fig. 14, the apertures can also be modified so that they do not extend into the strike face recess.

Referring to Fig. 23, the insert 110' has the flange 115' and is dimensioned so that a gap 130 is defined between the insert back face 117' and the bottom surface 106' of the

recess. The gap 130 and the apertures 114e' are filled with the second vibration dampening material 112b'. The club head 100' includes the groove 118' and the first vibration dampening material 112a' is disposed within the space 118'. In another embodiment, the gap 130 can be filled with a vibration dampening material that is different from that used in the apertures 114e'. For example, foam rubber can be used in the gap or another elastomeric material.

Referring to Fig. 24, the insert 110'' includes a flange 115'' similar to that in Figs. 20-22. However, the flange 115'' defines a plurality of circumferentially spaced notches 132. Referring to Fig. 25, when the insert 110'' is disposed in the club head 100'' so that a gap 130 is defined. The notches 132 define passages between the groove 118' and the gap 130. The notches 132 allow the second vibration dampening material 112b' from the gap to communicate with the first vibration dampening material 112a' in the groove so that the vibration dampening material is continuous from the strike face to the back face portion. The size and the shape of the notches may vary.

Referring to Fig. 26, the insert 110''' includes a plurality of spaced first portions or projections 134 defining spaces 118''' there between. The projections 134 extend radially outwardly from the platform portion 116'''. The projections 134 are not flush with the front face 136. When the insert is installed in the club head recess, the projections are in contact with a portion of the side wall surface, more specifically, the angled side wall surface portions 109 (as best shown in Fig. 21). The projections 134 center the insert within the recess. There should be a large enough number of projections so that the insert can be located accurately within the recess. The preferred number is four.

When the insert is disposed into the club head, a gap 130 (as shown in Fig. 23) is defined. The platform portion 116''' defines the peripheral groove in the strike face. The first vibration dampening material is disposed in the peripheral groove. The spaces 138 between the projections 134 are passageways that allow the second vibration dampening material from the gap 130 to communicate and be continuous with the first vibration dampening material in the groove. The size and the shape of the projections 134 may vary.

The inserts shown in Figs. 24 and 26 can also be used without the gap as shown in Fig. 22. This will allow the amount of vibration dampening material in the recess to vary, thus providing different levels of dampening.

The amount of vibration dampening material in the club head can be varied in a number of ways. For example, the number of apertures or number of apertures filled with the vibration dampening material can be varied. In addition, the geometry of the peripheral groove can be varied by changing the width w (as shown in Fig. 20), by changing the depth D (as shown in Fig. 23), by changing the geometry of the flange or projections, or by changing the size of the gap. Varying the amount of vibration dampening material affects the feel of the club head and allows the club head to be custom fit to a particular player or group of players depending on their needs, preferences, and/or performance. If a player, such as a Tour player, prefers more metal-to-metal contact the amount of vibration dampening material can be decreased. If as a group ladies, seniors or juniors, for example, prefer less metal-to-metal contact the amount of vibration dampening material can be increased. Thus, the club head of the present invention allows the manufacturer to modify the club head to satisfy one player or a group of players, which is advantageous.

Referring to Figs. 6 and 16, the inserts 110, 110', 100'', and 110''' can be formed with a second flange, such as 68 or 68' that extends from the face of the insert that will be adjacent the strike face 22 once installed. This second flange is larger than the recess 44 and 44' so that once the insert is installed the second flange is adjacent the strike face 22. Prior to inserting the vibration dampening material into the space, formed as discussed above, the second flange is machined off.

According to the present invention and referring to Figs. 26a and 27, a golf club 210 has a shaft 212 (only partially shown) attached to a club head 214. A putter-type club head is shown in Fig. 26a. The club head 214 has a hosel 216 that accepts the shaft 212 with a heel 218 at the hosel end of the club head 214 and a toe 220 opposite of the heel 218. The club head 214 also has a sole portion 226 and an opposite top portion 228. Extending between the heel 218 and the toe 220 is a strike face 222, which is the surface that contacts the golf ball (not shown) upon impact between the golf club 210 and the ball. The strike face 222 includes a "sweet spot," or the center of gravity in the toe to heel direction, which is covered with an insert 224. The insert 224 is made of a material that is different than the rest of the club head. In the preferred embodiment, the insert is made of a tellurium copper alloy, which is a relatively soft alloy that improves the touch and feel of the club. In the preferred embodiment, the tellurium copper alloy includes a minimum of 99.4% copper, a maximum of .004-.012 ppm of phosphorus and a maximum of 0.4-0.7 ppm of tellurium, and has a hardness of approximately 80 HB. A vibration damping material 246 as discussed below surrounds the insert.

Referring to Fig. 28, the strike face 222 defines a recess 230 having a bottom surface 232 and a side wall surface 234 surrounding the bottom surface 232. The side

wall surface 34 includes a plurality of portions 236-240. The pair of horizontal side wall portions 236 are substantially parallel to one another, and generally horizontal. The pair of vertical side wall portions 238 are substantially parallel to one another, and generally vertical. The four corner side wall portions 240 extend between adjacent horizontal and vertical side wall portions to form angled surfaces.

As shown in Fig. 27, the club head 214 has an essentially flat back face portion 242 that extends partially between the heel 218 and the toe 220 and partially between the top portion 228 and the sole portion 226. The back face portion 242 has a plurality of apertures 244 that are preferably evenly spaced apart in relation to each other. The apertures also follow the contour of the back face portion 242 and are essentially perpendicular to the strike face 222 (as shown in Fig. 26a).

Turning to Fig. 28, the apertures 244 extend from the back face 242 toward the insert 224. Preferably more than five apertures are used, more preferably there are greater than 20 apertures, and most preferably there are 32 apertures. A vibration dampening material 246, such as an elastomeric material, that is deformable is located in each aperture 244. In the preferred embodiment, which will be described in detail below, the elastomeric material is a silicone material, Stock No. GE281, available from General Electric Company in Waterford, NY.

Referring to Fig. 28, the integrally formed insert 224 includes a first portion or projections 248 and a second or platform portion 250. The projections 248 are spaced apart and extend radially outwardly from the platform portion 250. The projections 248 define the spaces 251 there between. The insert 224 further includes a back face 252. Each projection 248 includes a front surface 253 spaced from the front

surface 255 of the platform portion 250. The projections 248 are sized to fit within the recess 230. When the insert 224 is inserted in the recess 230, the back face 252 is in contact with the bottom surface 232 of the recess 230.

Furthermore, the projections 248 are disposed adjacent and in contact with the bottom surface 232 and the side wall surface portions 236-240. In the installed position, the platform portion 250 includes an outer peripheral edge, which is spaced from at least a portion of the side wall surface, to define a peripheral groove 254 (as shown in Figs. 28-30) between the platform portion 50 and the side wall surfaces 236-240. The projections 248 center the insert within the recess. The peripheral groove 254 surrounds the platform portion 250 of the insert. The groove has a width, designated by the arrow w in Fig. 26a.

Referring now to Figs. 27-29, the apertures 244a-e receive a fastening means 258a-e. The outermost apertures 244a-d has complementary counterbores. The aperture 244e is a central aperture that receives a center fastener 244e. The insert back face 252 includes five threaded holes 260a-e (shown in phantom) that are complimentary to the apertures 244a-244e in the club head 210. The five fasteners 258a-258e are fastened into the insert holes 260a-e. The fasteners 258a-e connect the insert 224 to the club head. The fasteners are used during machining as discussed above.

Referring to Fig. 29, the top row of apertures are designated 244f. When the insert 224 is disposed within the recess 230, the aperture or space 251 between the projections 248 is located so that it is partially aligned with the top row of apertures 244f. As a result, as best shown in Fig. 29A, a portion of the top row apertures 244f are visible from the front of the club head within the groove 254 before the vibration dampening material is disposed within the club

head. The portion of the apertures (shown in phantom) are covered by the platform portion 250 of the insert.

As shown in Figs. 29, 29a, and 30, once the vibration dampening material is disposed in the groove 254 and the apertures 244 and the space 251 provides a passageway for allowing the elastomeric material in the groove 254 to be in fluid communication with the elastomeric material in the apertures 244. Thus, the vibration dampening material is continuous from the strike face 222 to the back face portion 242.

Referring to Figs. 28 and 30, also when the insert 224 is within the recess 230, the front surface 253 of the projections 248 is spaced from the strike face 222 and the front surface 255 of the platform portion 250 forms a portion of the strike face 222. As a result, the passageway in the insert is spaced from the strike face 222.

In this embodiment, the top row of apertures are aligned with the spaces between the projections. In other embodiments, the insert can be configured so that, for example, the top row and the bottom row of apertures are partially or fully aligned with associated spaces between the projections.

The contact between the insert and the club head creates a metal-to-metal contact between the insert and the recess surfaces. The size of the apertures 244 and the volume of the elastomeric material 246 located in the apertures and the grooves and spaces combine to reduce the amount of metal-to-metal contact between the insert 224 and the recess surfaces. Therefore, the "touch and the feel" of the putter may be altered by varying the amount of metal-to-metal contact and by proportionately varying the amount of elastomeric material located around the insert.

Referring to Fig. 31, the insert 324 has been modified to include a first portion which is a flange 348. The flange

148 extends radially outwardly from the platform portion 350. The flange is sized to fit within the recess 330 of the club head 310 shown in Fig. 32. This club head is similar to the club head discussed above. The insert 324 is fastened within the club head as discussed previously.

Referring to Fig. 31, the flange 348 defines upper and lower notches or passageways 351a and b, respectively. Referring to Fig. 32, the notches 351a and b are sized so that when the insert 324 is disposed within the recess 30, a pair of the two center apertures 344f in the top and bottom rows of the apertures are completely aligned with the notches 351a and 351b.

Referring to Fig. 33, it is shown that by completely aligning the notches 351a and b with the holes 344f the vibration dampening material in the groove 354 is in fluid communication with the vibration dampening material in the apertures, and the vibration dampening material is continuous from the strike face 322 to the back face portion 342.

In this embodiment, the portion of the insert forming the apertures 351a and b is not in contact with the bottom surface 332 of the recess. The remaining portion of the back face 352 of the insert 324 is in contact with the bottom surface of the recess. The metal-to-metal contact of the insert and the recess surfaces is reduced by using the vibration dampening material.

In another embodiment, the flange can be configured so that the notches are partially aligned with various apertures in the club head. Furthermore, the shape, location, and number of the notches can be varied while still providing the passageway as desired.

Referring to Fig. 31A, the insert 324' is similar to the insert 324 shown in Fig. 31, and similar features have the same reference numeral followed by a prime. The insert 324' has been modified to include a flange 348'. The flange 348'

extends radially outwardly from the platform portion 350'. The flange is sized to fit within the recess 330 of the club head 10 shown in Fig. 32A. This club head is similar to the club head discussed above. The insert 324' is fastened within the club head as discussed previously.

Referring to Fig. 31A, the flange 348' defines a pair of upper and lower notches or passageways 351a' and b', respectively. Referring to Fig. 32A, the notches 351a' and b' are sized so that when the insert 324' is disposed within the recess 330, a pair of the apertures 344f' at the toe side and a pair of the apertures 344f' at the heel side are completely aligned with the respective notches 351a' and 351b'. This embodiment allows metal-to-metal contact of the insert 324' with the bottom surface of the recess over the sweet spot and more vibration dampening toward the toe and heel. Thus, off-center hits should be provided more dampening.

Referring to Fig. 34A, the insert 424 has been modified and includes a first portion which is a flange 448. The flange 448 extends radially outwardly from the platform portion 450. The flange is sized to fit within the recess 430 of the club head 310 shown in Fig. 34. The flange 448 defines a pair of upper and lower apertures 451a and b, respectively.

Referring to Figs. 35 and 36, the back face 452 of the insert 424 further includes a plurality of cavities 452. The cavities 452 are aligned to be complementary with the apertures 444. Some of the apertures 444 receive the fasteners as previously discussed to secure the insert 424 to the club head.

Referring to Figs. 35 and 36, four of the cavities 452a are formed so that they include a counterbored portion 454 and a reduced diameter portion 456. The counterbored portion 454 extends from the insert back face 452 to the reduced

diameter portion 456. The counterbored portion 454 is configured so that it forms the apertures 451a and b and a cutout 458 extending between the apertures 451a and b and the reduced portion of the cavities 456. The cavities and counterbores which form the apertures 451a are located so that the apertures 451a are notches extending to the periphery of the flange. The cavities and counterbores which form the apertures 451b are located so that the apertures 451b extend through the flange spaced from the periphery of the flange.

Referring to Figs. 34, 34a and 35, when the insert 424 is disposed within the recess 430, the cavities 452a are aligned with the apertures 444. As shown in Fig. 36, the passageway from the groove 454 to the apertures 444 is formed by each aperture 451 a and b and the associated the counterbores 454. The vibration dampening material 446 is disposed within the groove 454, the apertures 451a and b, the cavities 452a, and the apertures 444. The vibration dampening material 446 in the apertures 444, and the vibration dampening material 446 is continuous from the strike face 422 to the back face portion 442.

In this embodiment, the portion of the insert forming the counterbores and cavities is spaced from the bottom surface 432 of the recess. The remaining portion of the insert 424 is in metal-to-metal contact with the bottom surface of the recess. The insert cavities 452 and 452a provide a more pronounced vibration dampening feature than the embodiment disclosed in Figs. 28 and 31, since the amount of metal-to-metal contact will be decreased using the insert 424 versus the inserts 224 and 324. This results from the elastomeric material 446 extending into the back face 452 of the insert 424 due to the cavities. So the elastomeric material encompasses more area on the back face of the insert 424.

In another embodiment, the back face of the insert can be modified so that the cutouts have a different shape. Furthermore, the location and number of the apertures and cavities can be varied while still providing the passageway as desired.

Referring to Fig. 37, the insert 524 is similar to the insert 424 shown in Figs. 34-36, and for use with the club head shown in Fig. 34. Similar portions of the insert 524 to the insert 524 begin the reference with a number "5" instead of "4". The back face 552 of the insert 524 further includes a continuous passageway 560 or a matrix. The passageway 560 connects each of the insert cavities 552 and 552a. The passageway is formed using conventional techniques so that the insert back face landings or areas 558 remain between portions of the passageway. In this embodiment, the depth of the passageway 560 does not equal the depth of the cavities 552 so the cavities 552 remain after the passageway is formed.

The front of the insert 524 is similar to that shown in Fig. 34A where the insert includes the flange and the platform portion. The counterbored portions 554 form apertures 551 and b in the flange. The insert 524 is fastened within the club head as discussed previously.

Referring to Figs. 34, 36 and 37, once the insert 524 is disposed in a club head, the passageway from the groove 454 to the apertures 444 is formed by each aperture 551 in the flange and the associated cavities 552a with the counterbores. The vibration dampening material 446 is disposed within the groove 454, the apertures 551 in the flange, the cavities 552, and the apertures 444. The vibration dampening material 446 is continuous from the strike face 422 to the back face portion 442.

In this embodiment, the portion of the insert forming the counterbores and cavities is spaced from the bottom

surface of the recess. The remaining portion of the insert 524 (i.e., the landings 558 and the remaining area of the back face 552) is in contact with the bottom surface of the recess. This is metal-to-metal contact. The continuous passageway 560 provides a more pronounced vibration dampening feature than the embodiment disclosed in Fig. 35 since the amount of metal-to-metal contact will be decreased using the insert 524 versus the insert 424.

In another embodiment, the back face of the insert can be modified so that the cavities have a different shape and/or the passageway connects the cavities in a different arrangement. Furthermore, the location and number of the apertures and cavities can be varied while still providing the passageway as desired. In addition, the passageway can be continuous through the cavities so that separate lines or shapes are formed by the back face passageway.

Referring to Fig. 38, the insert 624 is for use with a club head similar to that shown in Fig. 34, and includes a flange 648 similar to that shown in Fig. 31. However, the flange 648 defines a plurality of circumferentially spaced notches 651. However, the back face 652 of the insert 624 further includes a plurality of projections 660 (shown in phantom) extending therefrom at spaced locations. The insert 624 is fastened within the club head as discussed previously.

Referring to Figs. 39 and 40, when the insert 624 is disposed within the recess 630, the free ends 662 of the projections 660 are portions of the back face that are in contact with the bottom surface 632 of the recess 630. The remaining portion 664 of the back face is spaced from the bottom of the recess so that a gap 666 is defined there between. The vibration dampening material 646 within the gap 666 is in fluid communication with the vibration dampening 646 material within the apertures 644. Referring to Fig. 40, the notches or apertures 651 define passageways between the

groove 654 and the gap 666 and the apertures 644. The vibration dampening material 646 is continuous from the strike face 622 to the back face portion 642.

In this embodiment, the projections 660 provide metal-to-metal contact between the insert and the recess 630. A club head with the insert 624 exhibits a different touch and feel than a club head with a similarly configured insert which does not have projections but defines a gap between the back face of the insert and the recess bottom. The gap 666 may provide a more pronounced vibration dampening feature than the embodiment disclosed in Figs. 27-37, since the amount of metal-to-metal contact will be decreased using the gap.

Referring to Fig. 41, the insert 724 is for use with a club head similar to that shown in Fig. 34. The insert 724 is similar to the insert 224 shown in Fig. 28. However, the projections 748 have an increased thickness so that the portion 726 of the back face of each projection is spaced from the remaining portion 728 of the back face. Thus, the projection back face portion 726 is spaced a distance 730 from the remaining portion 728. When the insert 724 is disposed in a club head similar to that described in Fig. 26a, the portions 726 are in contact with the bottom surface 232 of the recess 230. The remaining portion 728 of the back face is spaced from the bottom of the recess so that a gap similar to the gap 666 (shown in Figs. 39 and 40) is defined there between. The vibration dampening material 646 within the gap is in fluid communication with the vibration dampening material within the apertures 544. Similarly to Fig. 40, the spaces 751 between the projections 748 define passageways between the groove 654 and the gap 666 and the apertures 644. The vibration dampening material 646 is continuous from the strike face 622 to the back face portion 642.

In this embodiment, the projections 748 provide metal-to-metal contact between the insert and the recess 630. A club head with the insert 724 exhibits a different touch and feel than a club head with a similarly configured insert which does not have projections but defines a gap between the back face of the insert and the recess bottom, as discussed above.

In another embodiment, the back face of the inserts 624 and 724 can be modified to include notches of different sizes, locations, and shapes. Furthermore, the back faces can include cavities, counterbored portions and passageways as discussed above.

In another embodiment, the various portions of the golf club head can be filled with two or more different vibration dampening materials. For example, foam rubber or another elastomeric material can be used.

During manufacture, depending on the configuration of the insert and the apertures, in order to introduce the elastomeric material into the club head, it is injected into the apertures and it may flow from the back face portion to the strike face. The configuration may require that the material is injected in the groove and the apertures so that the material will be continuous from the back face portion to the strike face. A squeegee is scraped across the back face portion and the strike face to remove the excess silicone, leaving the silicone in each of the apertures and the groove.

The amount of vibration dampening material in the club head shown in Figs. 27-40 can be varied in a number of ways. For example, the number of apertures or number of apertures filled with the vibration dampening material can be varied. In addition, the geometry of the peripheral groove can be varied by changing the width w (as shown in Fig. 26a), by changing the depth D (as shown in Fig. 30), by changing the

geometry of the flange or projections, or by changing the size of the gap.

As discussed above, varying the amount of vibration dampening material affects the feel of the club head and allows the club head to be custom fit to a particular player or group of players depending on their needs, preferences, and/or performance. If a player, such as a Tour player, prefers more metal-to-metal contact between the insert and recess bottom surface, the amount of vibration dampening material can be decreased. If as a group, ladies, seniors or juniors, for example, prefer less metal-to-metal contact the amount of vibration dampening material can be increased. Thus, the club head of the present invention allows the manufacturer to modify the club head to satisfy one player or a group of players, which is advantageous.

CLAIMS

We Claim:

1. A golf club head having a toe and an opposite heel, a sole portion and an opposite top portion, a forwardly facing exposed strike face and an opposite rearwardly facing exposed back face portion, comprising:

a) a recess defined in the strike face, said recess having a bottom surface spaced from the back face portion and a side wall surface extending between the bottom surface and the strike face;

b) an insert located in the recess, said insert having a peripheral edge spaced from the side wall surface to form a peripheral groove; and

c) a first vibration dampening material located in the peripheral groove.

2. The golf club head of claim 1, wherein the insert further includes a first portion and a second portion, the first portion extends radially outwardly from the second portion, and the first portion is in contact with a portion of the side wall surface and the second portion includes the peripheral edge.

3. The golf club head of claim 2, wherein the first portion further includes a plurality of spaced projections.

4. The golf club head of claim 2, wherein the first portion is a flange.

5. The golf club head of claim 4, wherein the flange further defines at least one notch.

6. The golf club head of claim 1, further including a plurality of apertures extending from said back face portion toward the recess and a second vibration dampening material located in at least one of said apertures.

7. The golf club head of claim 6, wherein the first vibration dampening material is in communication with the second vibration dampening material.

8. The golf club head of claim 6, wherein the first vibration dampening material and the second vibration dampening material are the same.

9. The golf club head of claim 8, wherein the first and second vibration dampening materials are elastomeric materials.

10. The golf club head of claim 9, wherein the elastomeric materials are silicone.

11. The golf club head of claim 6, wherein the insert further includes a back face and the back face is spaced from said bottom surface of the recess to define a gap.

12. The golf club head of claim 11, further including a third vibration dampening material located within the gap.

13. The golf club head of claim 12, wherein the third vibration dampening material is the same as the second vibration dampening material.

14. The golf club head of claim 12, wherein the first vibration dampening material and the second vibration dampening material are the same.

15. The golf club head of claim 6, wherein the second vibration material is disposed within all of the apertures.

16. The golf club head of claim 1, wherein the insert is formed of a tellurium copper alloy.

17. The golf club head of claim 6, further including a fastening means that extends through at least one of said apertures to connect said insert to said back face portion.

18. The golf club head of claim 6, wherein the back face of the insert further includes a plurality of cavities that are aligned to be complementary with said plurality of apertures.

19. A golf club head having a toe and an opposite heel, a sole portion and an opposite top portion, a forwardly facing strike face and an opposite rearwardly facing back face portion, comprising:

a) a metal insert located in the strike face, said insert having an exposed front face flush with said strike face and a back face engaging the club head;

b) a plurality of apertures extending into said back face portion;

c) a vibration dampening means located in at least one of said apertures; and

d) said insert and vibration dampening means being of different materials.

20. A golf club head having a toe and an opposite heel, a sole portion and an opposite top portion, a forwardly facing exposed strike face and an opposite rearwardly facing exposed back face portion, comprising:

a) a recess defined in the strike face;

b) an insert located in the recess; and

c) a vibration dampening material extending continuously from the strike face to the back face portion.

21. A golf club head having a toe and an opposite heel, a sole portion and an opposite top portion, a forwardly facing exposed strike face and an opposite rearwardly facing exposed back face portion, comprising:

a) a recess defined in the strike face, said recess having a bottom surface spaced from the back face portion;

b) an insert located in the recess, said insert having a first portion, a second portion, and a back face, the first portion including a front surface spaced from the strike face, and a first passageway extending from the upper surface to the back face of the insert; the second portion forms a portion of the strike face; and

c) a vibration dampening material located in the passageway.

22. The golf club head of claim 21, wherein the recess further including a side wall surface extending between the bottom surface and the strike face, said second portion including a peripheral edge spaced from the side wall surface to form a peripheral groove on the strike face, and the vibration dampening material located in the groove.

23. The golf club head of claim 22, further including a first aperture extending from said back face portion to the bottom surface, the vibration dampening material located in the first aperture, wherein the vibration dampening material is continuous from the strike face to the back face portion through the groove, the first passageway, and the first aperture.

24. The golf club head of claim 23, wherein the first passageway includes a second aperture unaligned with the first aperture.

25. The golf club head of claim 23, wherein the first passageway includes a second aperture at least partially aligned with the first aperture.

26. The golf club head of claim 23, wherein the first passageway includes a second aperture completely aligned with the first aperture.

27. The golf club head of claim 23, further including the back face in contact with the bottom surface, and the passageway further including a cutout in the back face extending from the second aperture to the first aperture.

28. The golf club head of claim 27, wherein the back surface of the insert further including a cavity aligned to be complementary with the first aperture, the cutout extending from the second aperture to the cavity, and the vibration dampening material extending into said insert cavity.

29. The golf club head of claim 21, wherein the first portion extending radially outwardly from the second portion, and the first portion is in contact with a portion of the side wall surface.

30. The golf club head of claim 21, further including a first plurality of apertures extending from said back face portion to the bottom surface, the first passageway for fluid communication between the groove and a group of the first plurality of apertures; and the vibration dampening material

located in the groove, the first plurality of apertures and the first passageway, wherein the vibration dampening material is continuous from the strike face to the back face portion.

31. The golf club head of claim 30, wherein the passageway includes a plurality of second apertures unaligned with the first plurality of apertures.

32. The golf club head of claim 31,wherein the back face is in contact with the bottom surface and the passageway further including a cutout in the back face extending from the second plurality of apertures to the group of the first plurality of apertures.

33. The golf club head of claim 31, wherein the back face of the insert further including a plurality of cavities aligned to be complementary with the first plurality of apertures, the cutout extending from the second plurality of apertures to a group of the cavities, and the vibration dampening material extending into said insert cavities.

34. The golf club head of claim 33, wherein each cavity in the group of cavities has a counterbored portion which forms the cutout.

35. The golf club of claim 33, wherein the insert back face further comprises:

a) a continuous second passageway connecting each of said insert cavities; and

b) the vibration dampening material extending through the continuous second passageway.

36. The golf club head of claim 34, wherein the first portion is a peripheral flange extending around the second portion, and each of the second plurality of apertures extending from the flange front surface to the back surface.

37. The golf club head of claim 36, wherein said second plurality of apertures is formed by the counterbored portion of the insert cavities.

38. The golf club of claim 37, wherein the insert back face further comprises:

a) a continuous passageway connecting each of said insert cavities; and

b) the vibration dampening material extending through the continuous passageway.

39. A golf club head having a toe and an opposite heel, a sole portion and an opposite top portion, a forwardly facing exposed strike face and an opposite rearwardly facing exposed back face portion, comprising:

a) a recess defined in the strike face, said recess having a bottom surface spaced from the back face portion;

b) an insert located in the recess, said insert having a first portion of the back face spaced from said bottom surface of the recess to define a gap between the first portion and the recess bottom surface, and the insert further includes a second portion of the back face in contact with the recess bottom surface; and

c) a vibration dampening material located in the gap.

40. The golf club head of claim 39, wherein the recess further including a side wall surface extending between the

bottom surface and the strike face, the second portion including a peripheral edge spaced from the side wall surface to form a peripheral groove on the strike face, and the vibration dampening material located in the groove.

41. The golf club head of claim 40, further including a first aperture extending from said back face portion to the bottom surface, the vibration dampening material located in the first aperture, wherein the vibration dampening material is continuous from the strike face to the back face portion.

42. The golf club head of 39, wherein the insert further including a plurality of radially extending peripheral projections, and the projections include the second portion of the back face.

43. The golf club head of claim 39, wherein said insert further includes at least one projection extending from the first portion of the back face, the projection including the second portion of the back face at the free end.

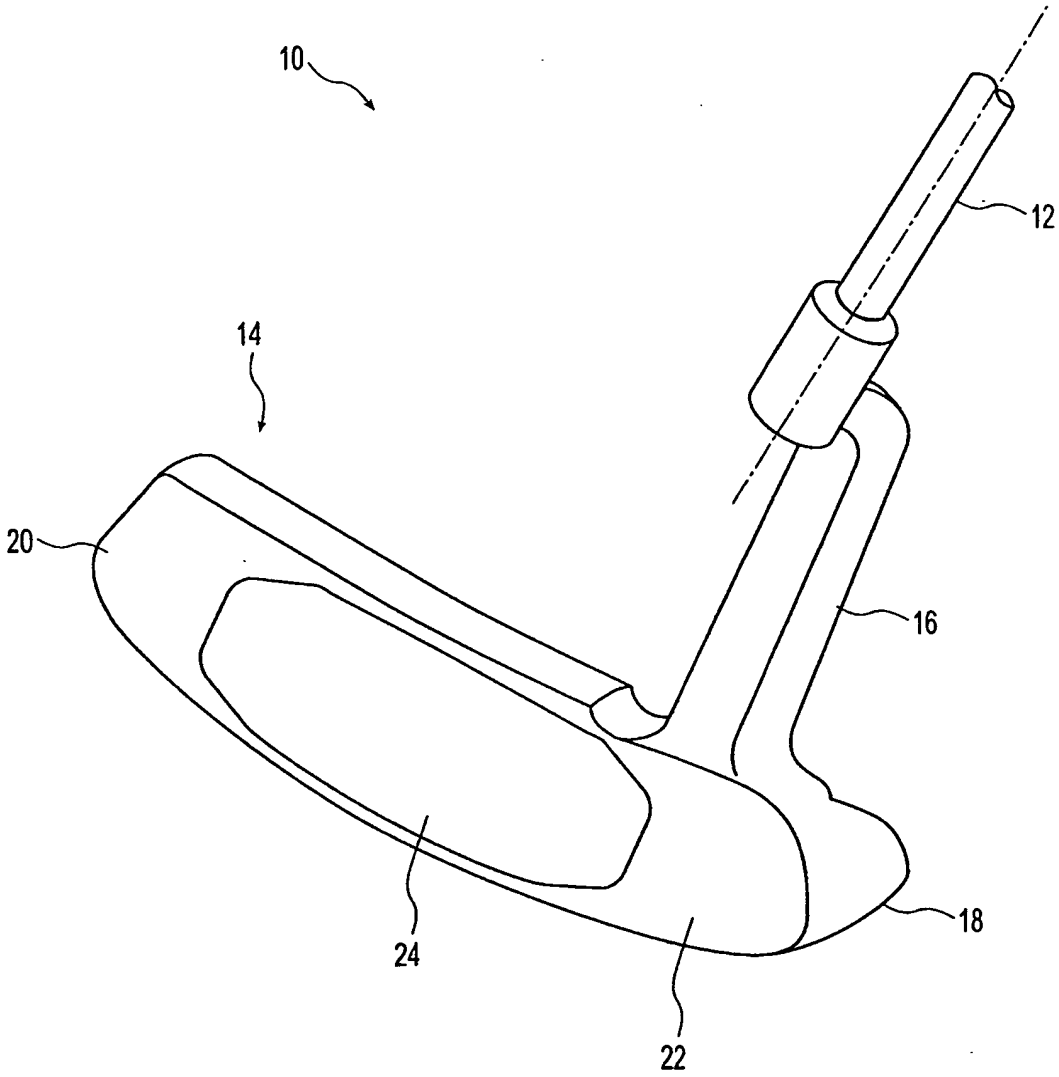


Fig. 1

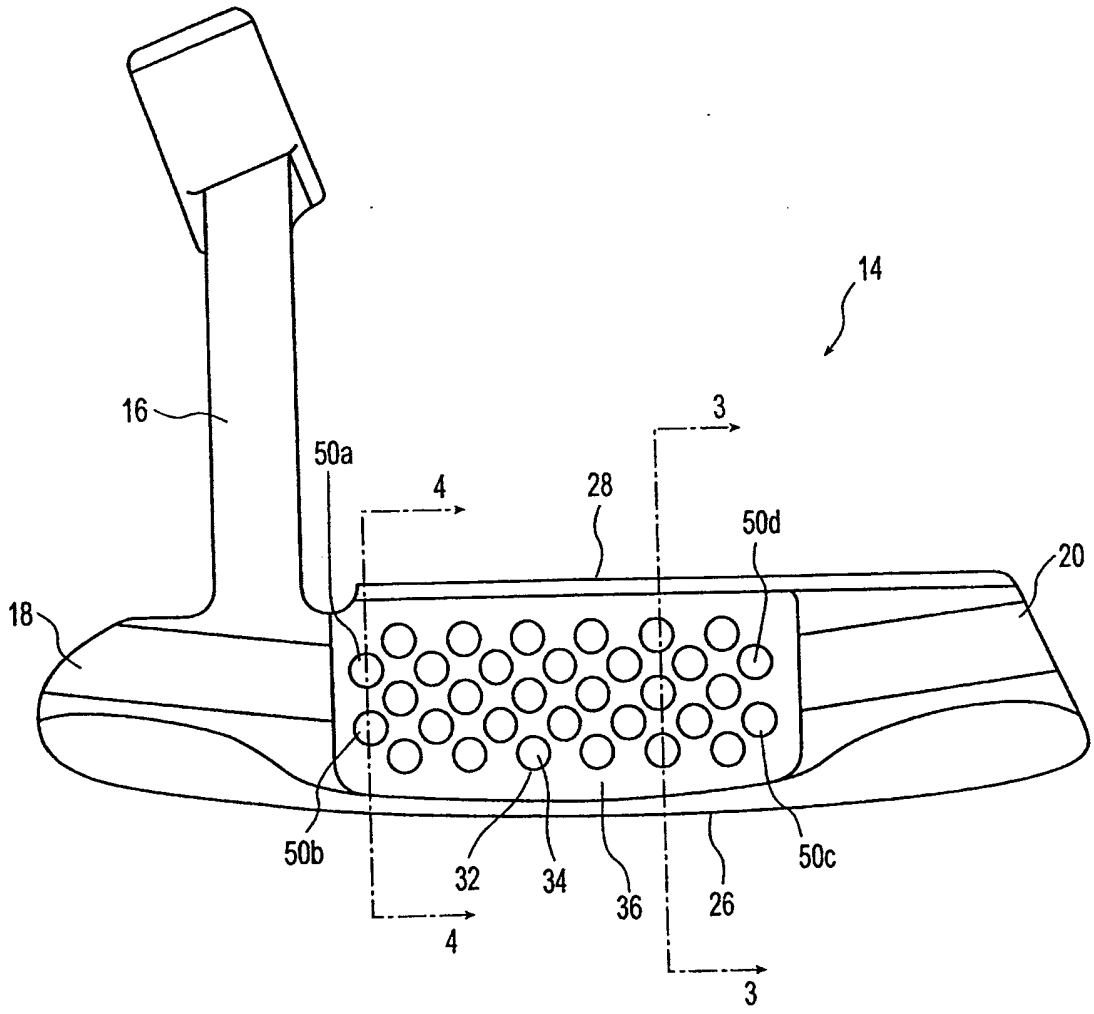


Fig. 2

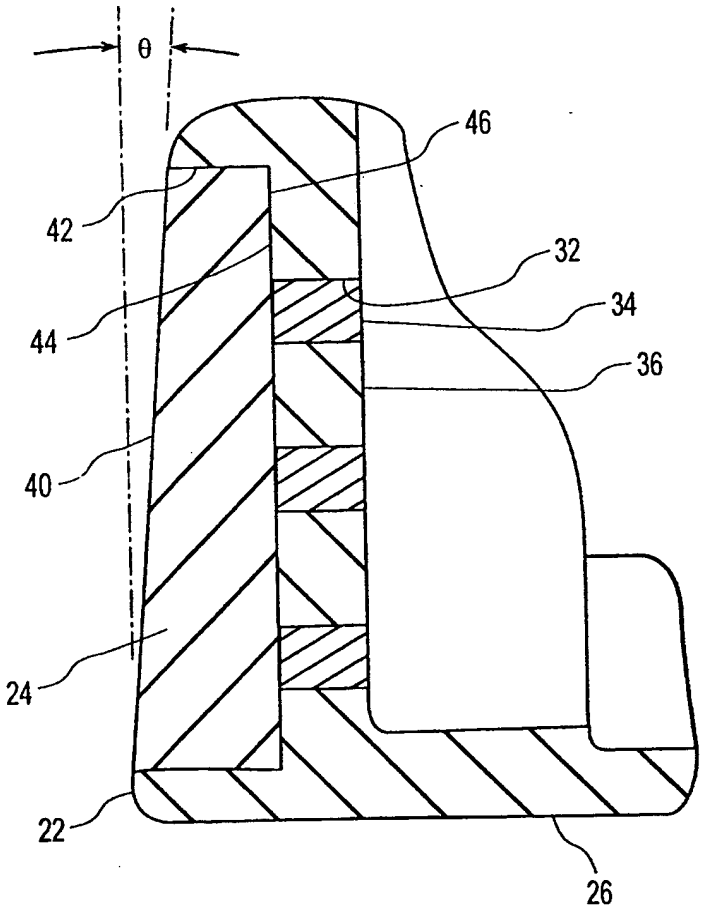


Fig. 3

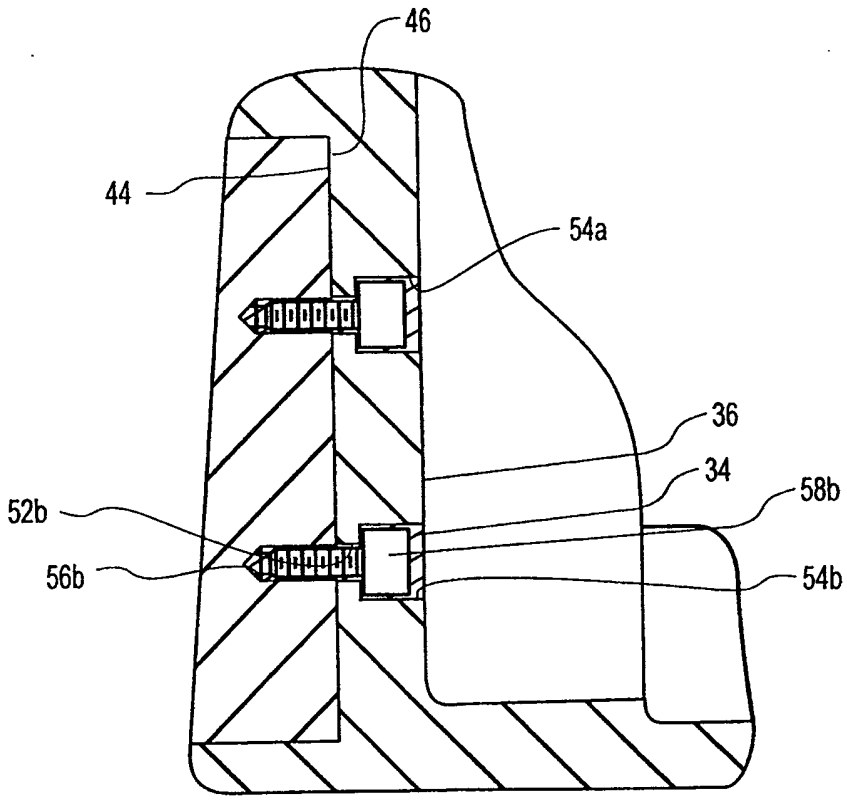


Fig. 4

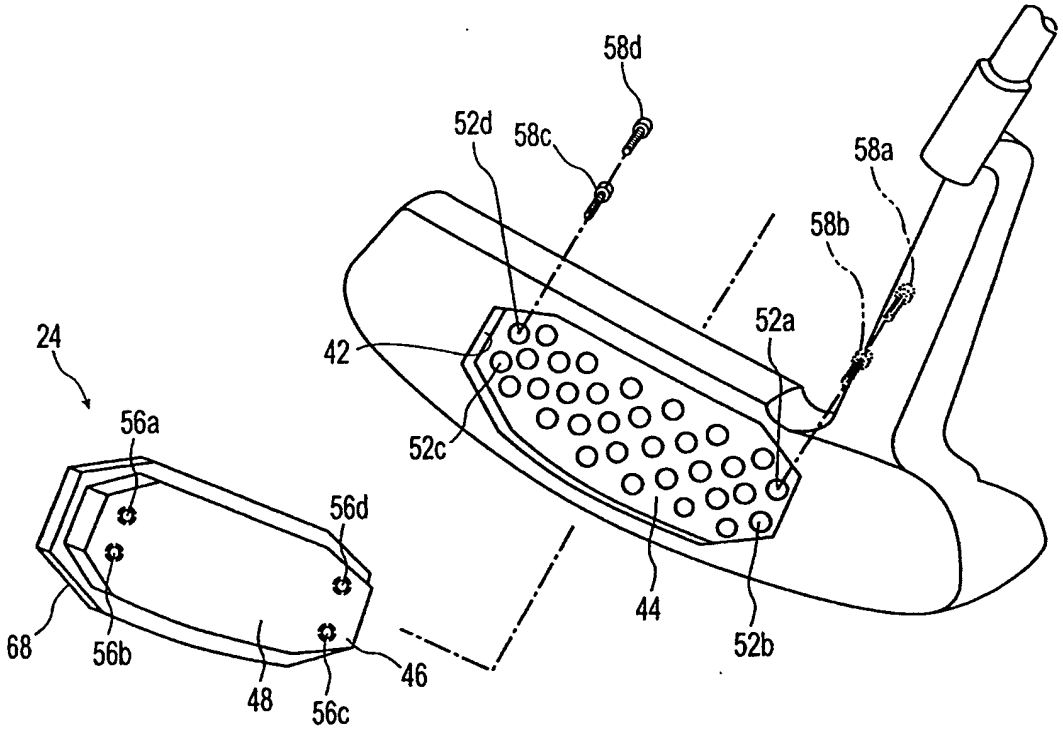


Fig. 5

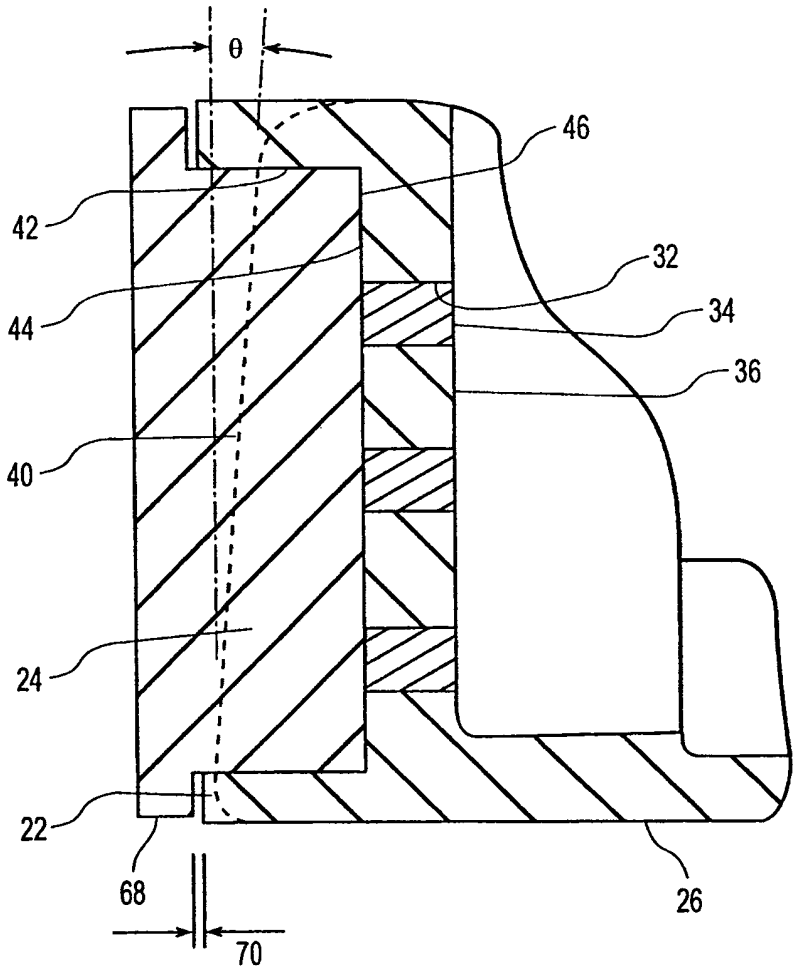


Fig. 6

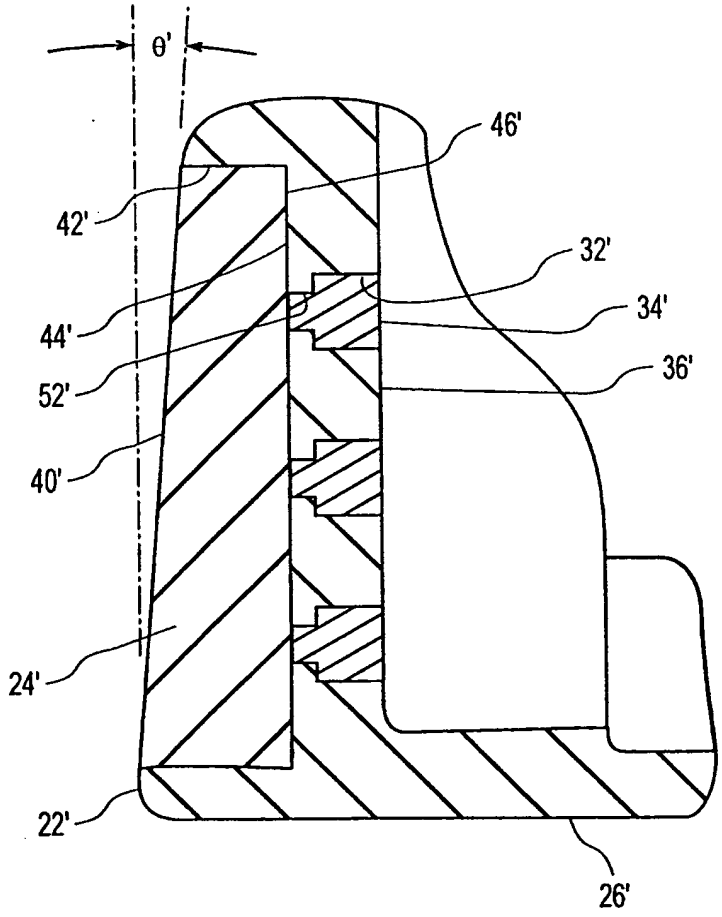


Fig. 7

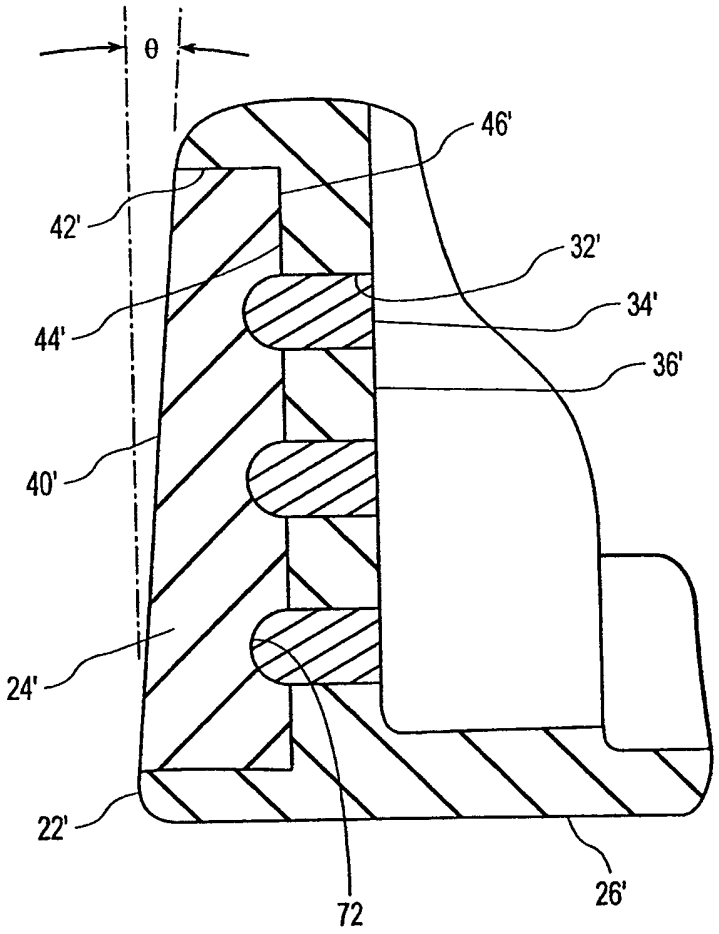


Fig. 8

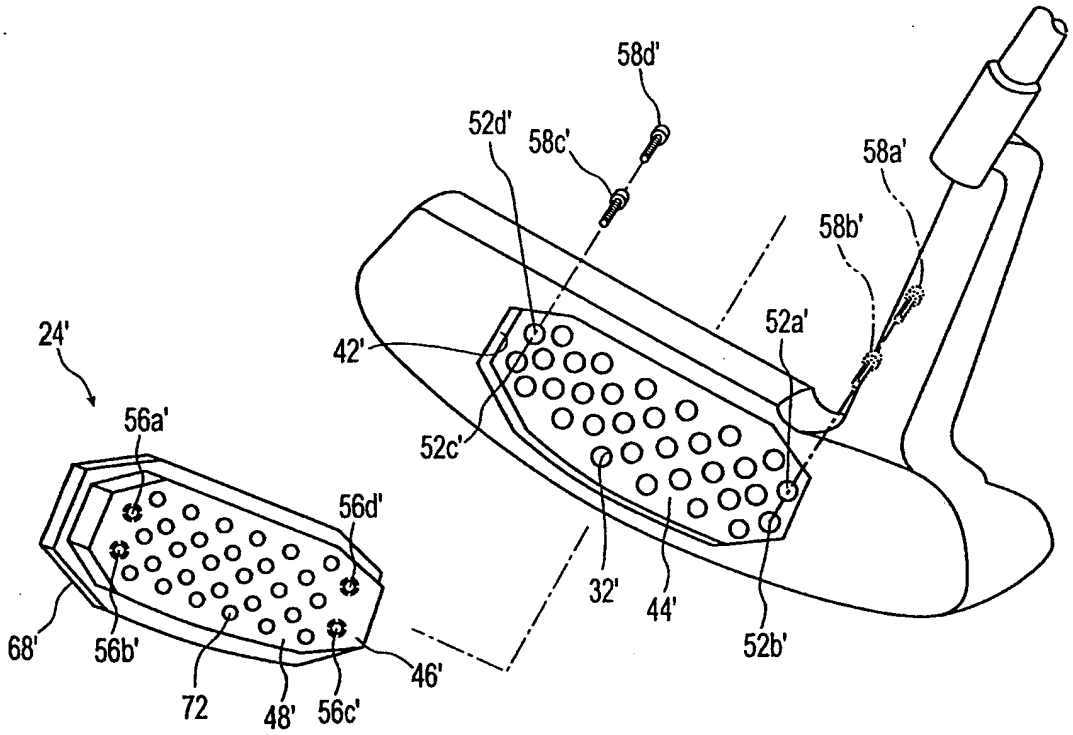

58d'
52d'
58c'
58a'
58b'
24'
42'
52a'
56a'
52c'
56d'
32'
44'
68'
56b'
52b'
46'
72
48'
56c'

Fig. 9

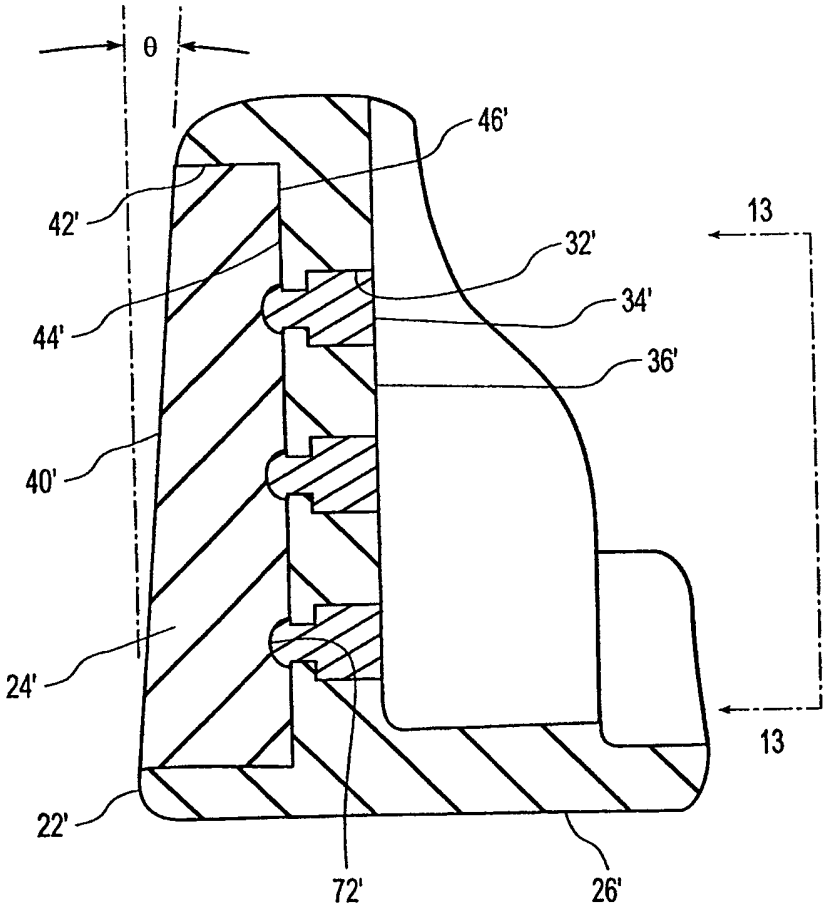


Fig. 10

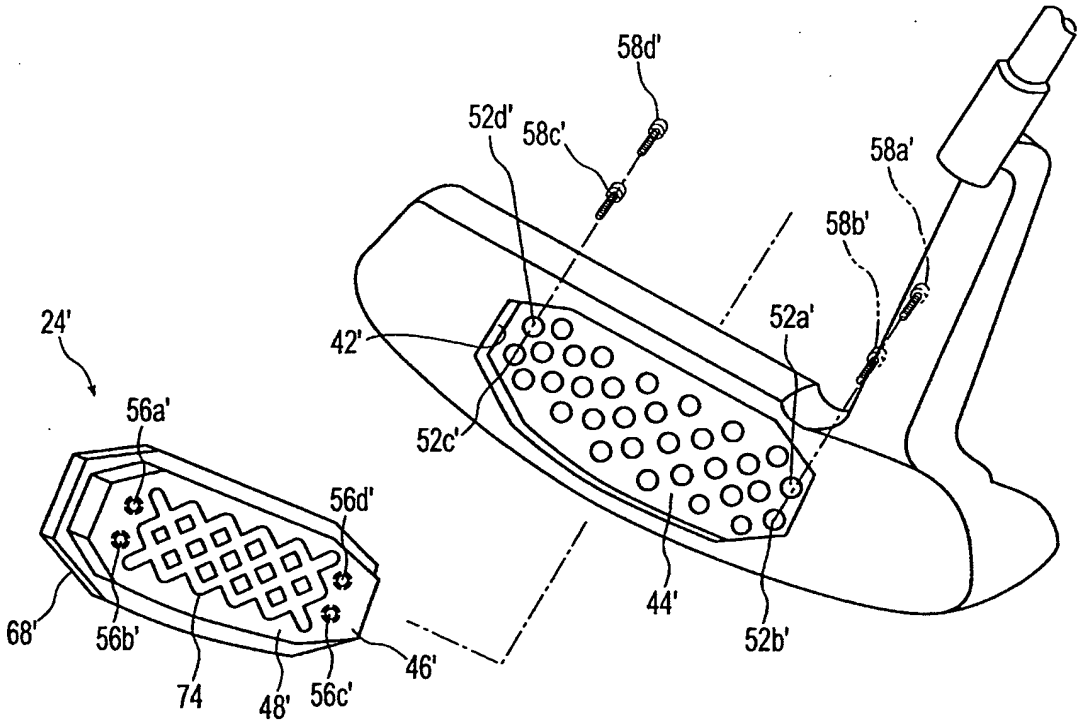

58d'
52d'
58c'
58a'
58b'
24'
42'
52a'
56a'
52c'
56d'
68'
56b'
74
48'
56c'
46'
44'
52b'

Fig. 11

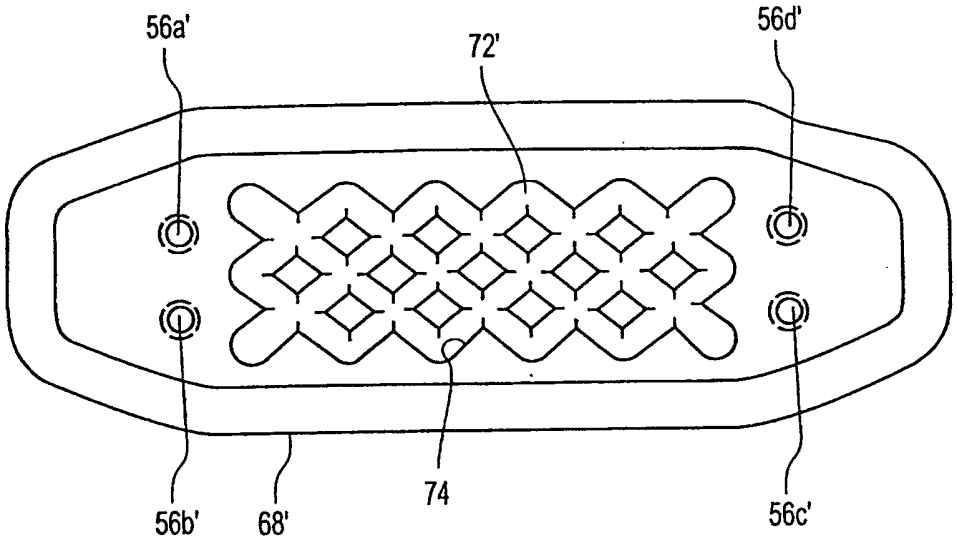


Fig. 12

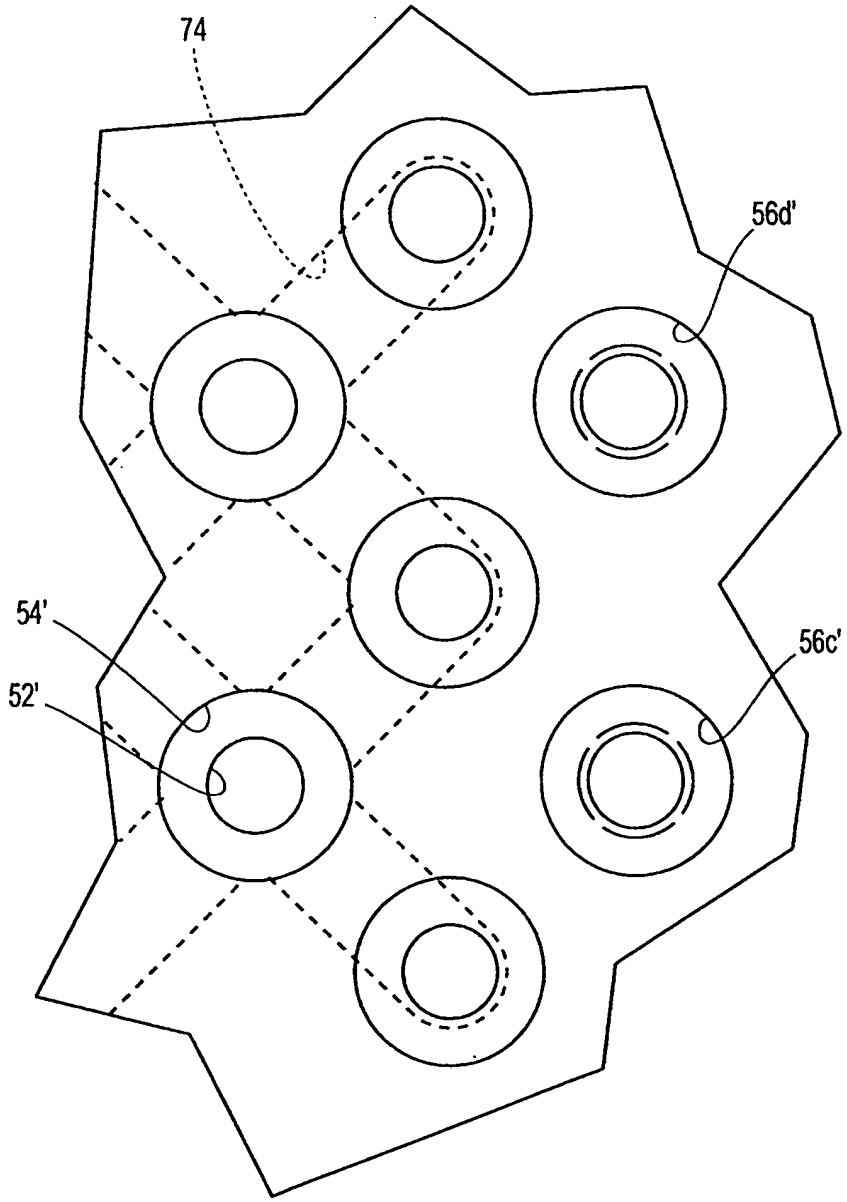


Fig. 13

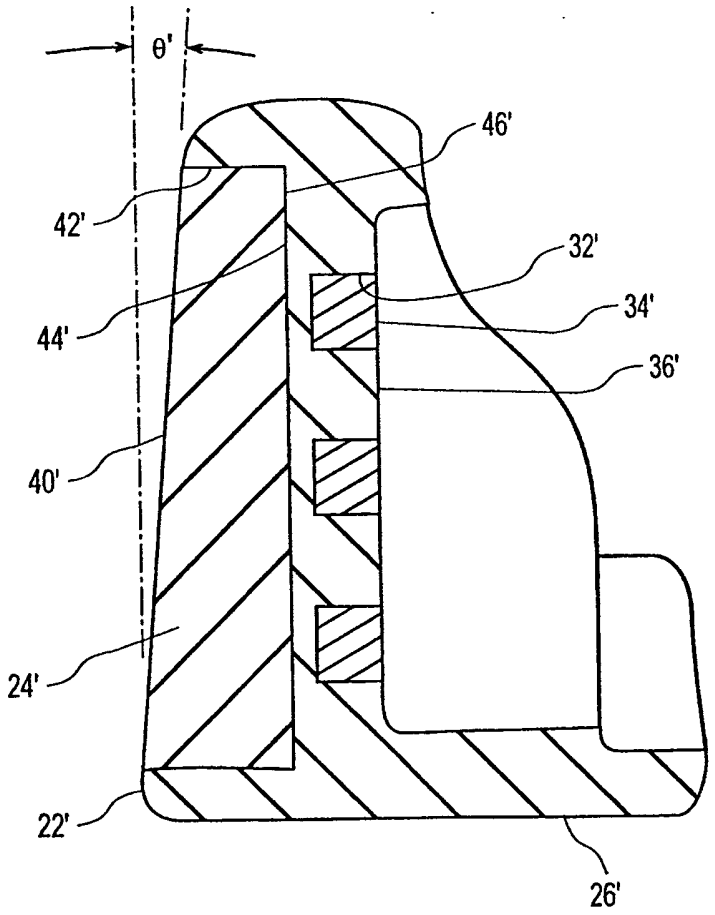


Fig. 14

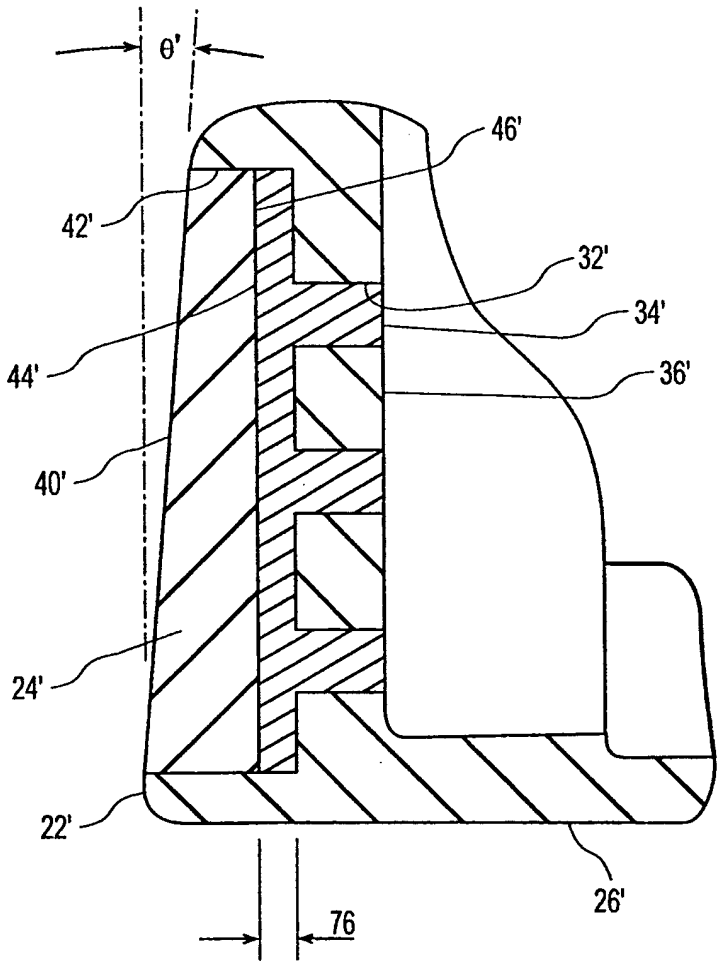


Fig. 15

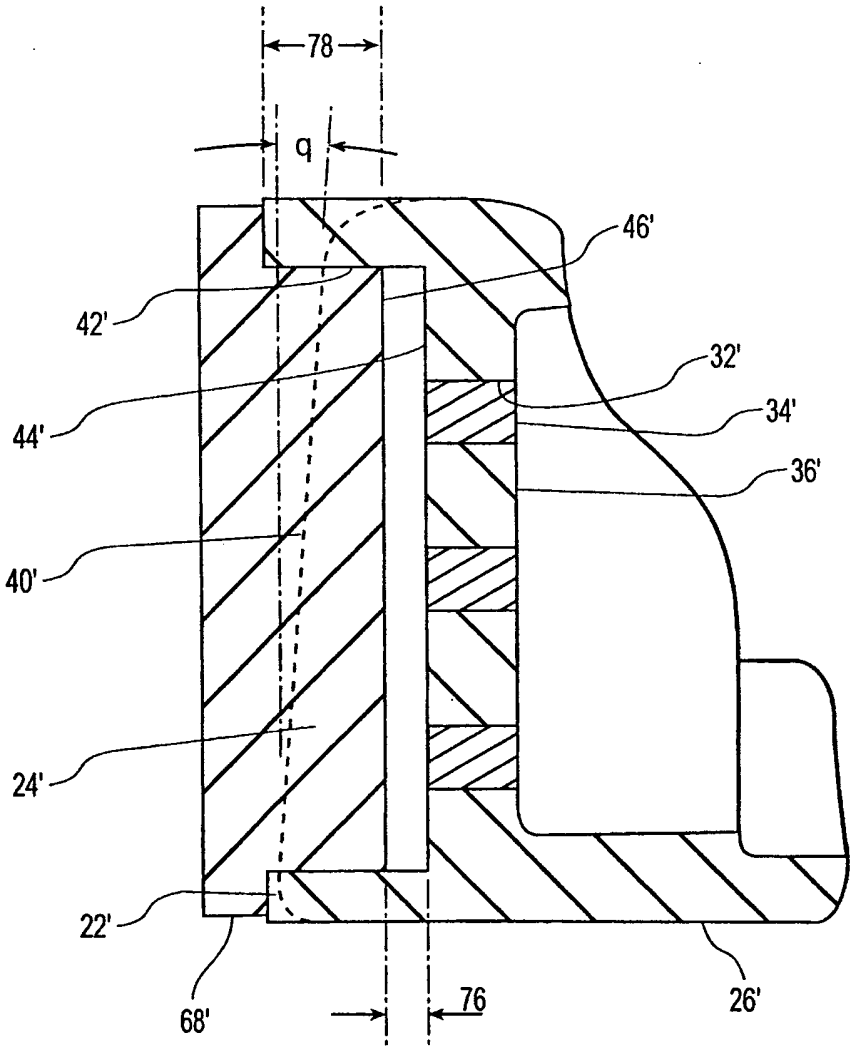


Fig. 16

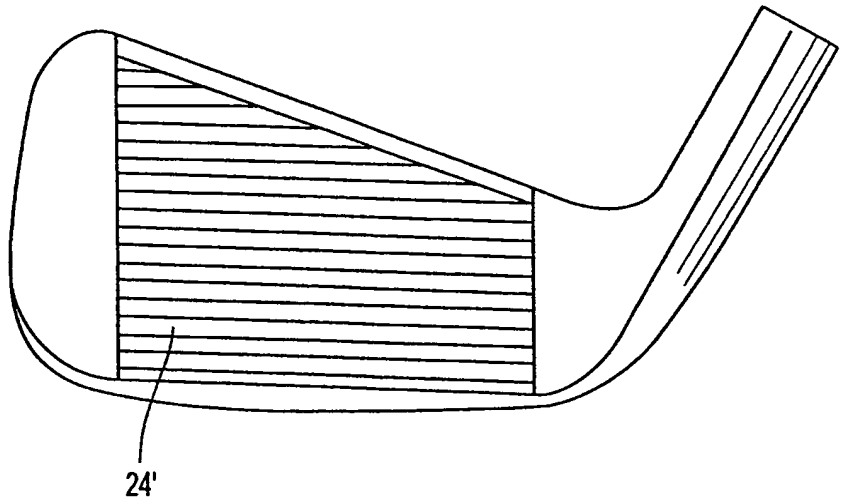


Fig. 17

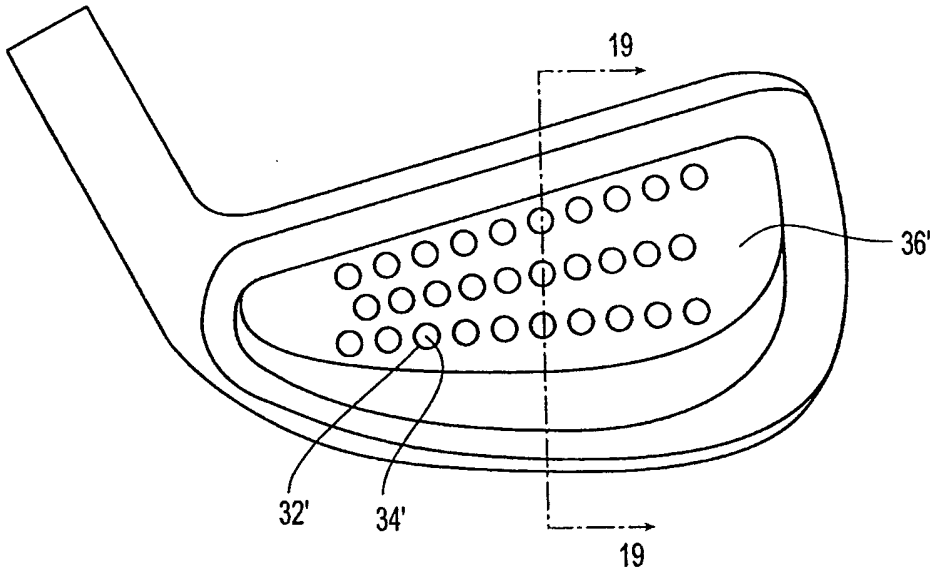


Fig. 18

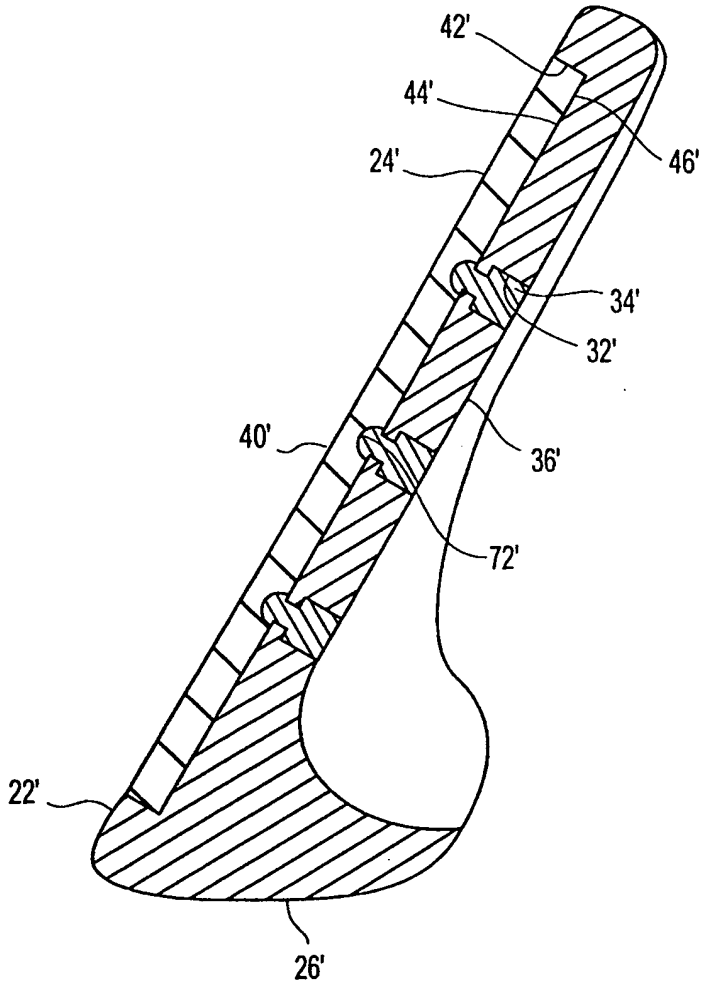


Fig. 19

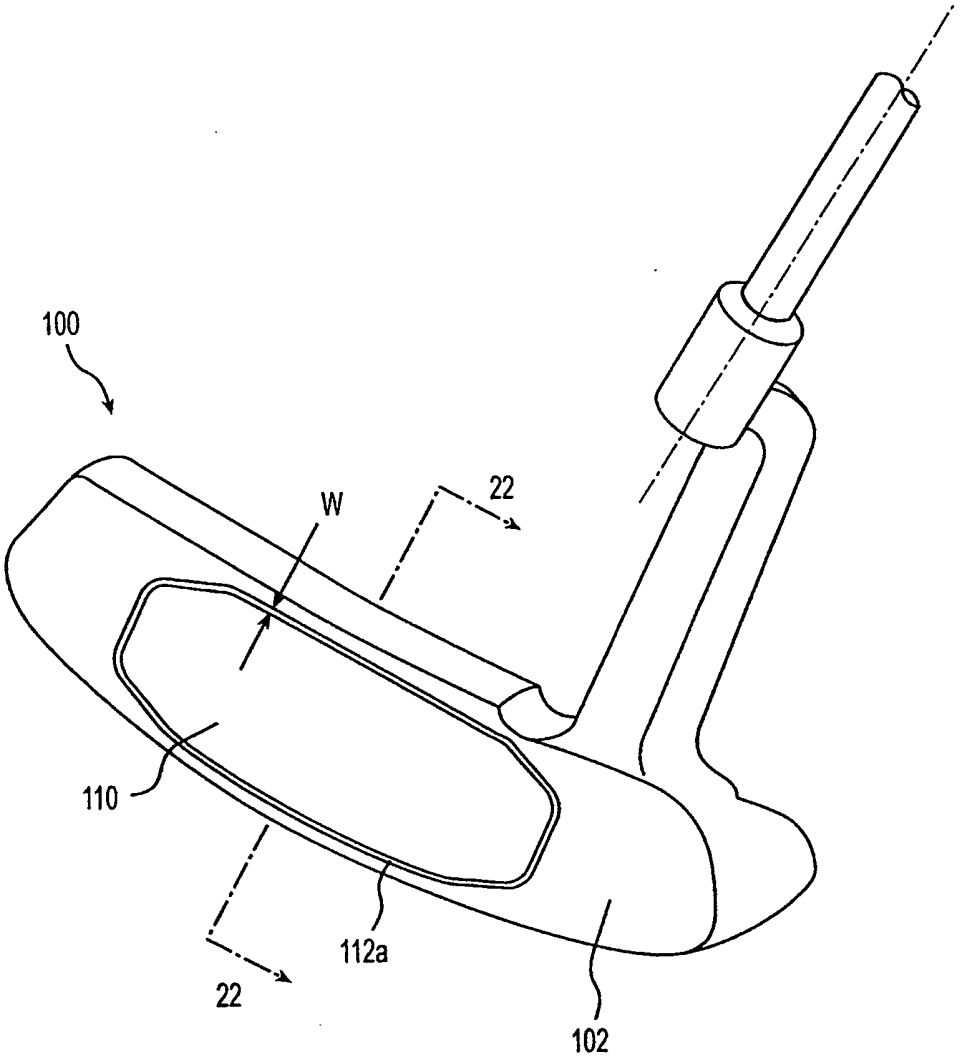
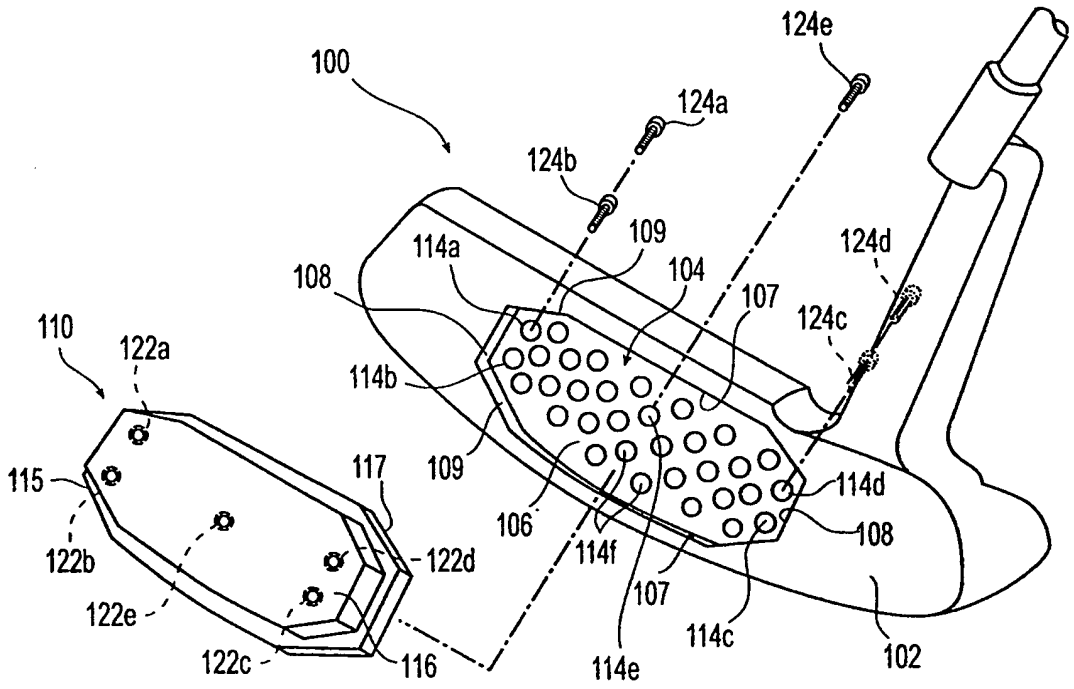


Fig. 20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114e
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Fig. 21

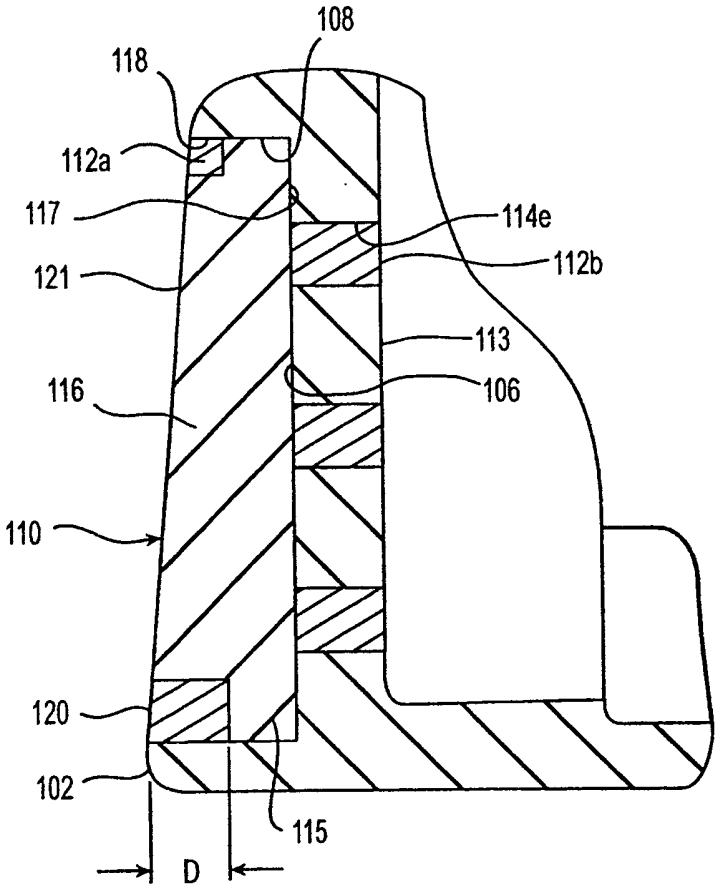
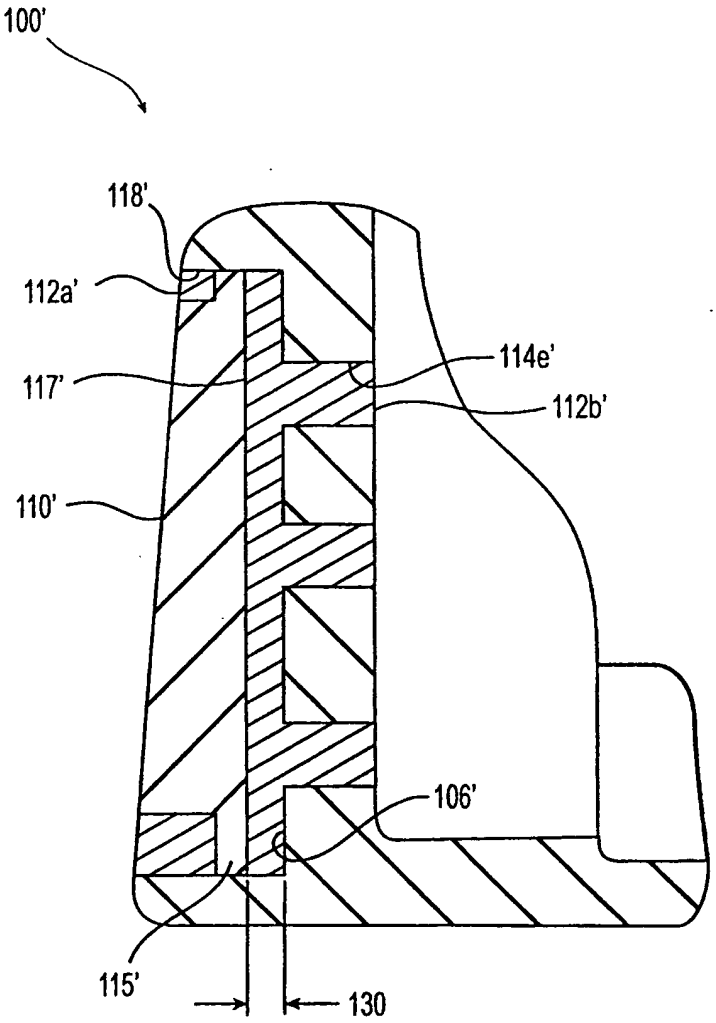


Fig. 22



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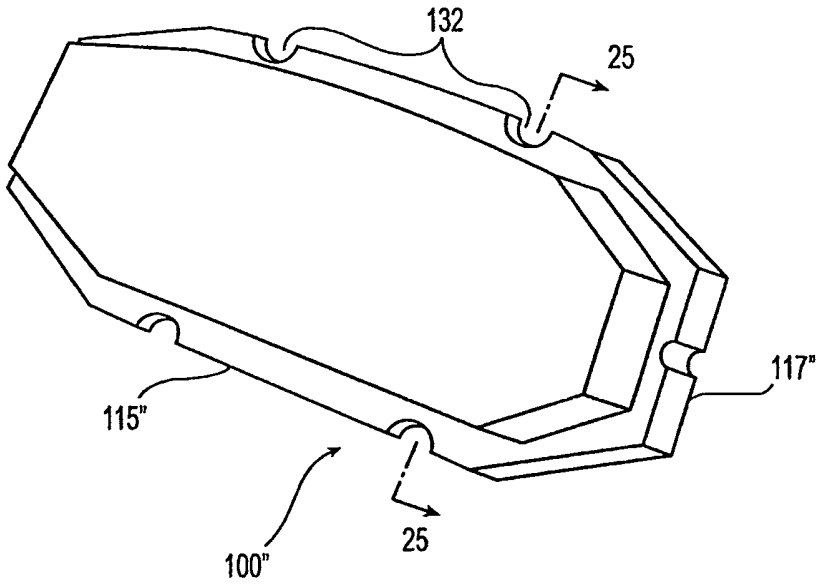

Fig. 24

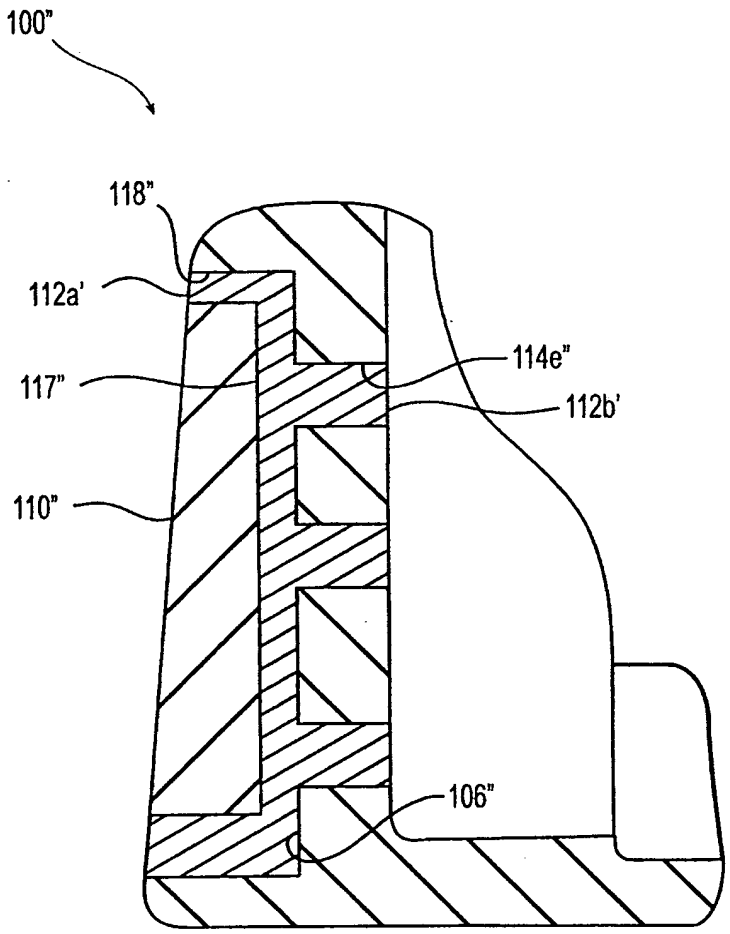

Fig. 25

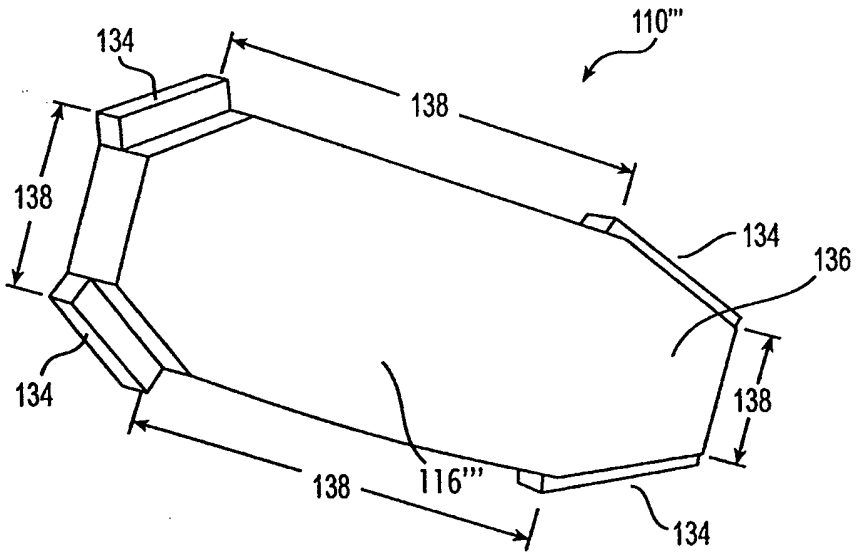

Fig. 26

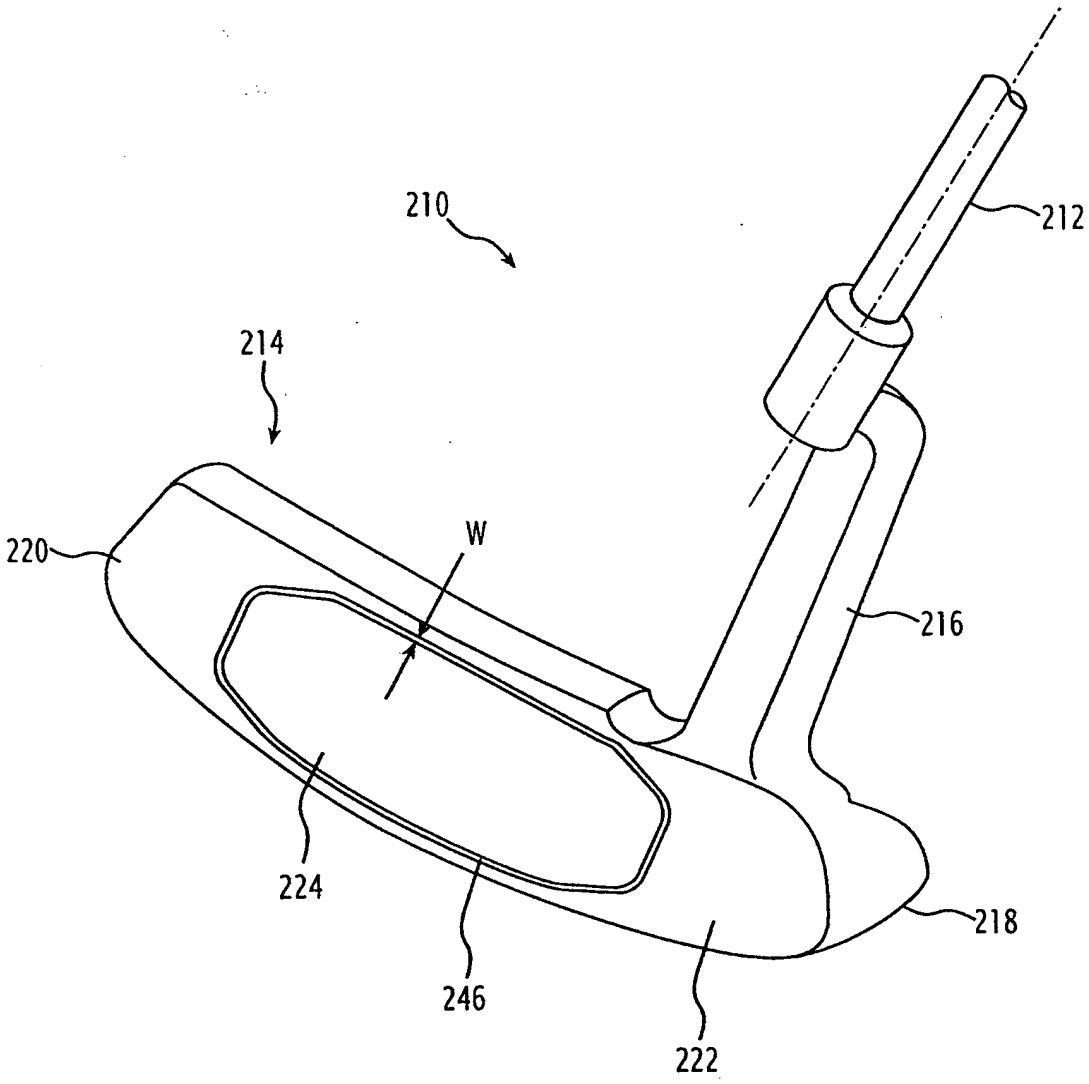

Fig. 26a

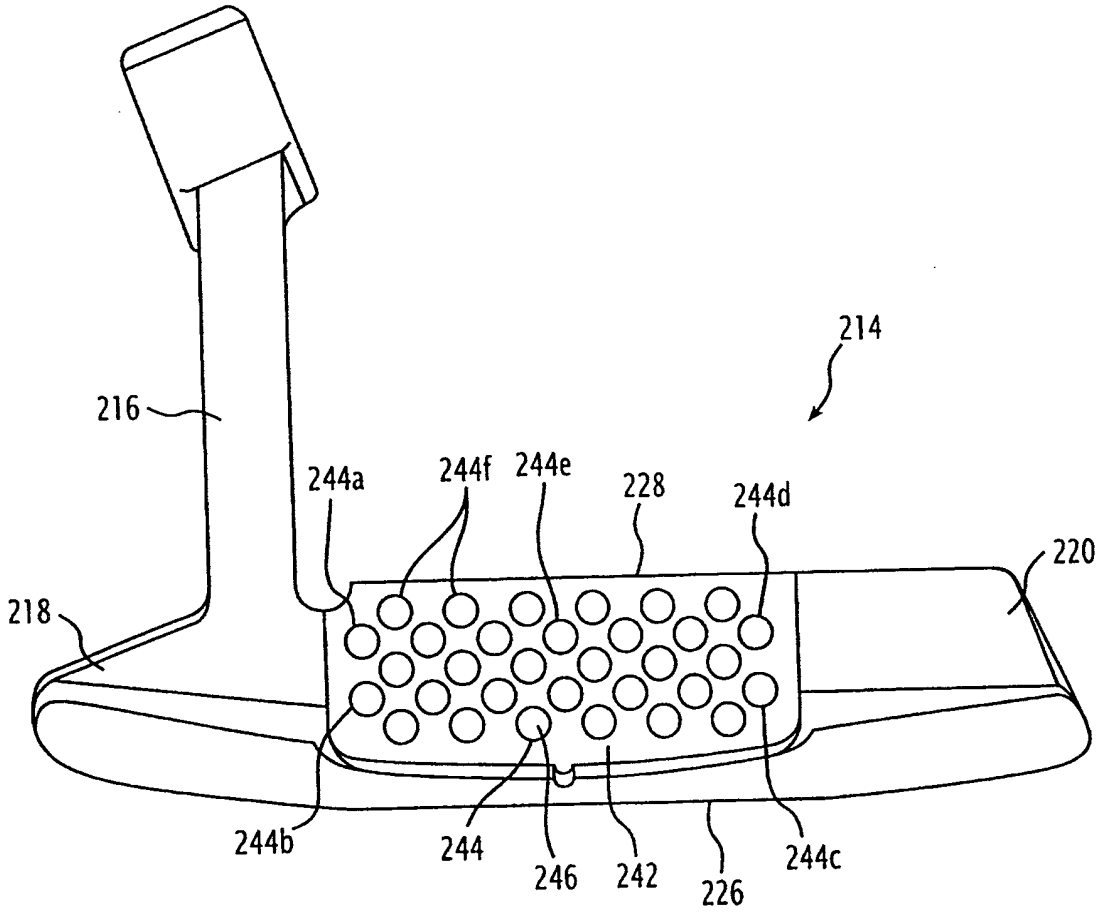
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Fig. 27

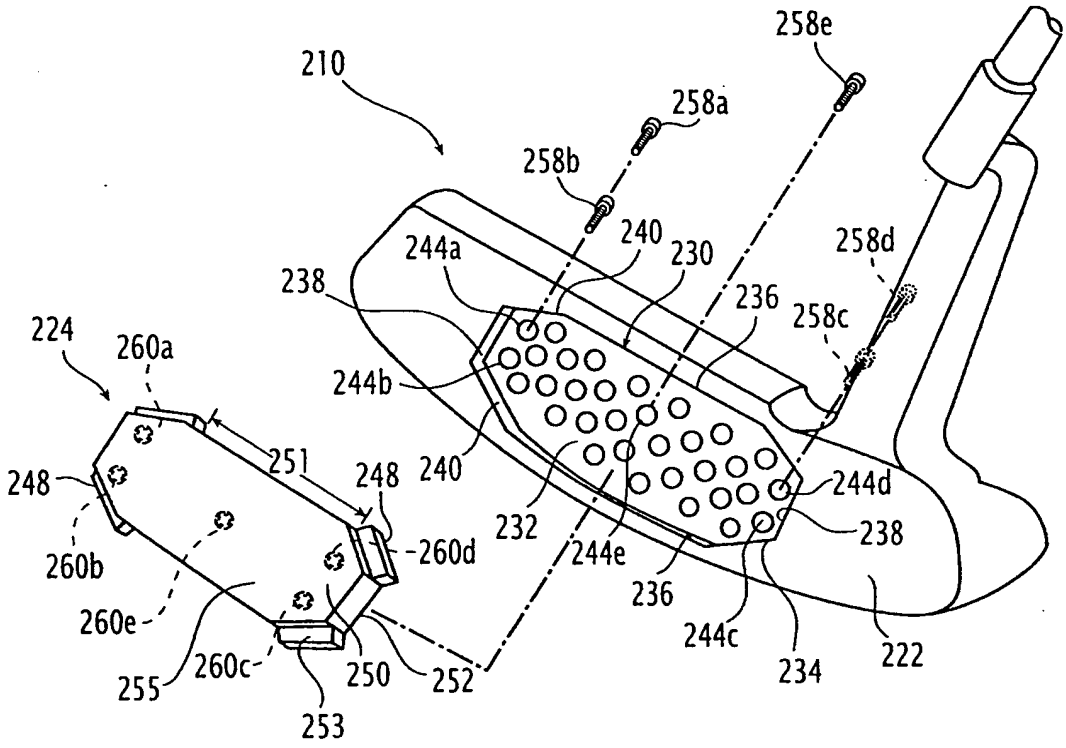
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Fig. 28

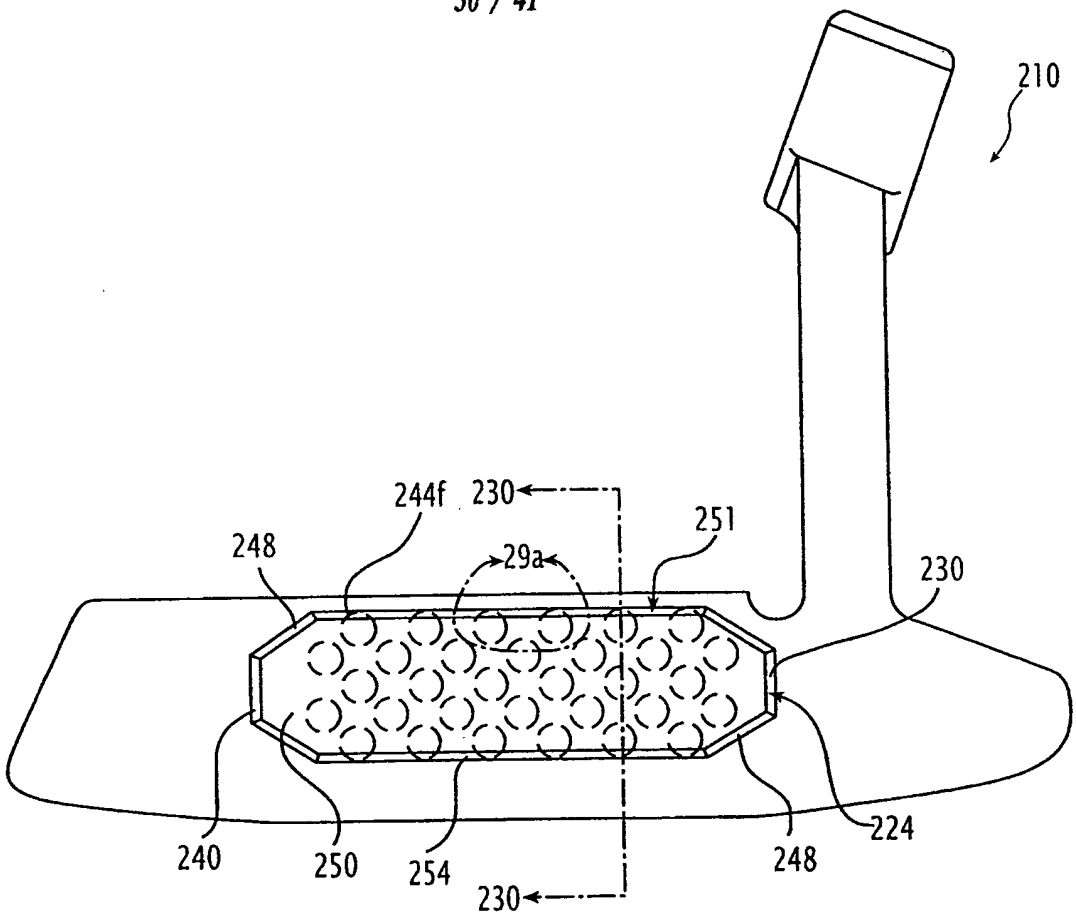

Fig. 29

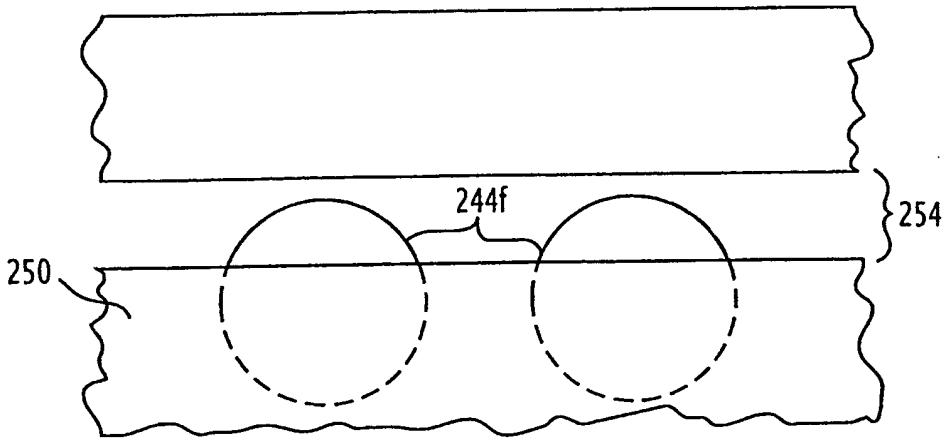

Fig. 29a

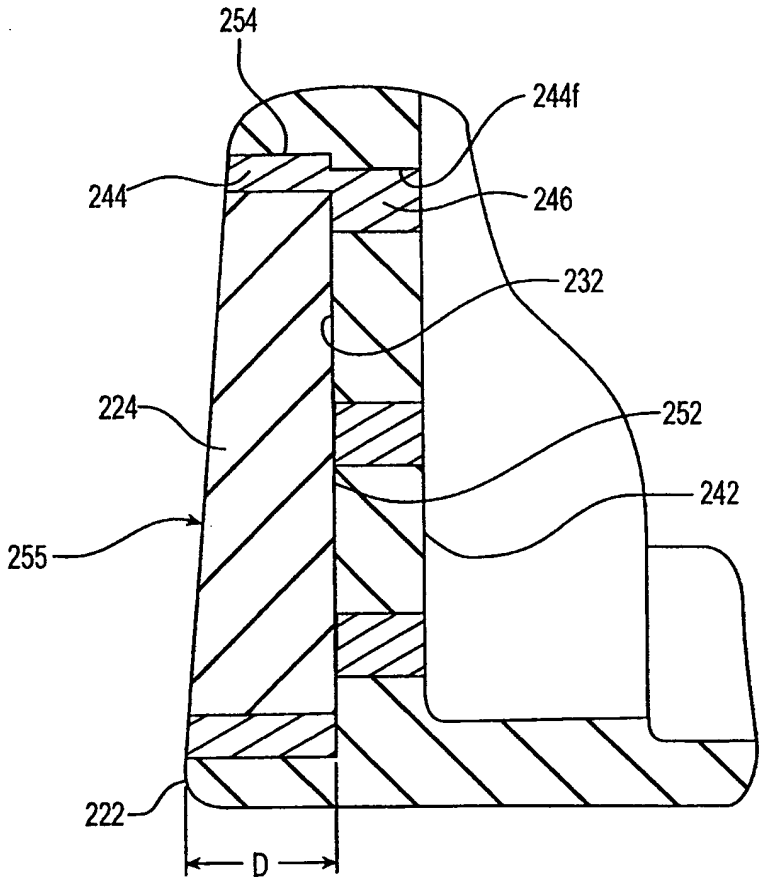

Fig. 30

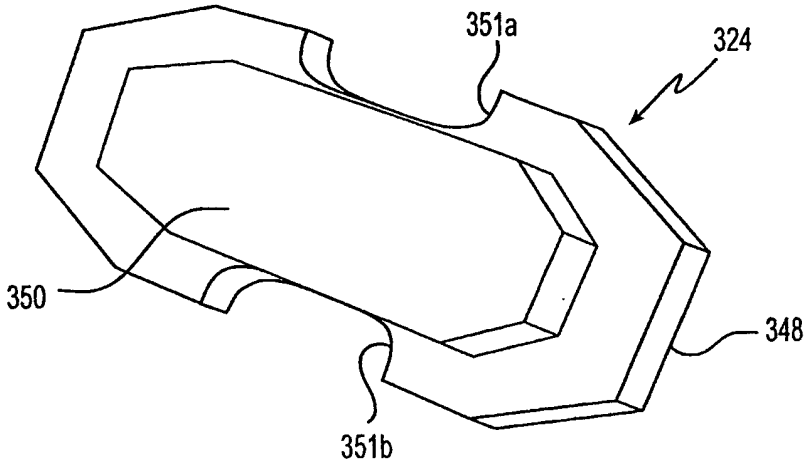
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Fig. 31

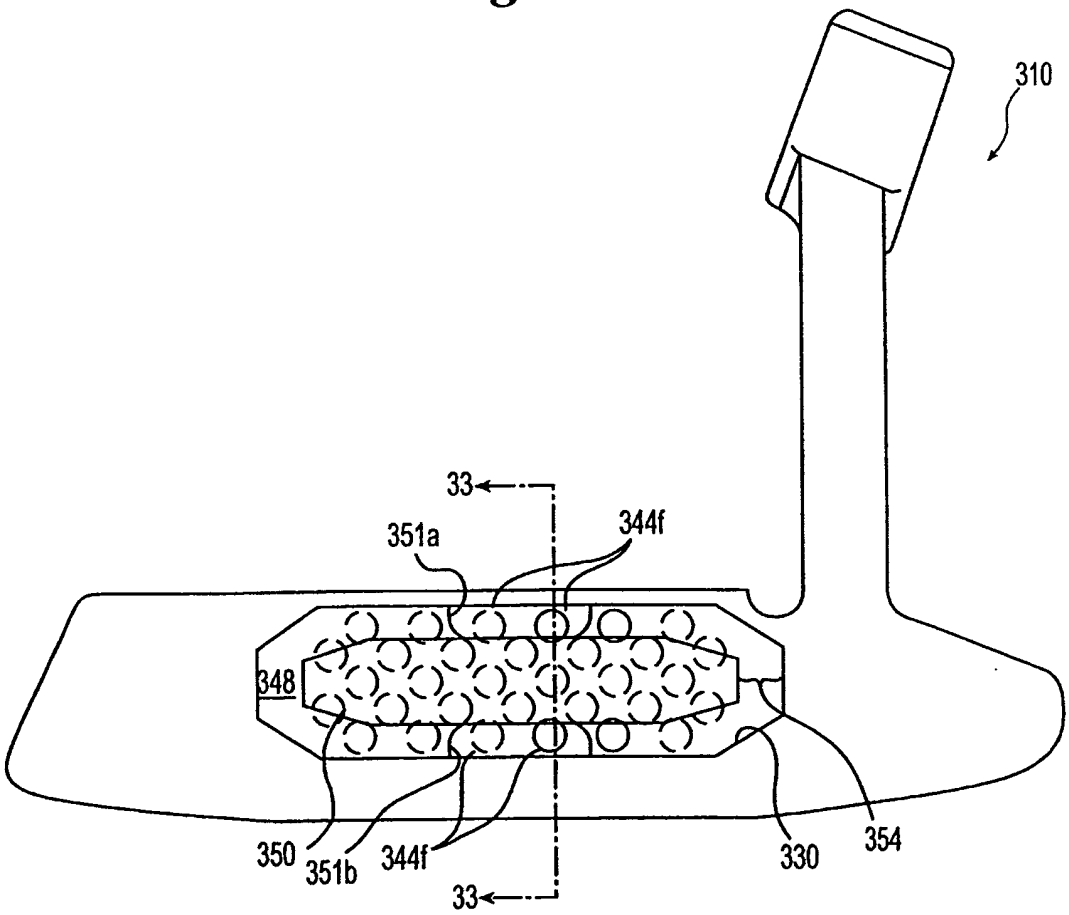
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Fig. 32

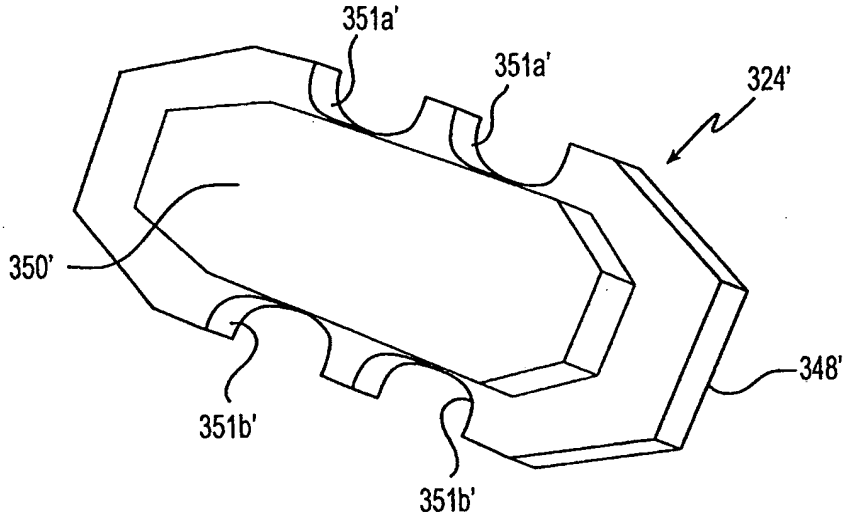


Fig. 31a

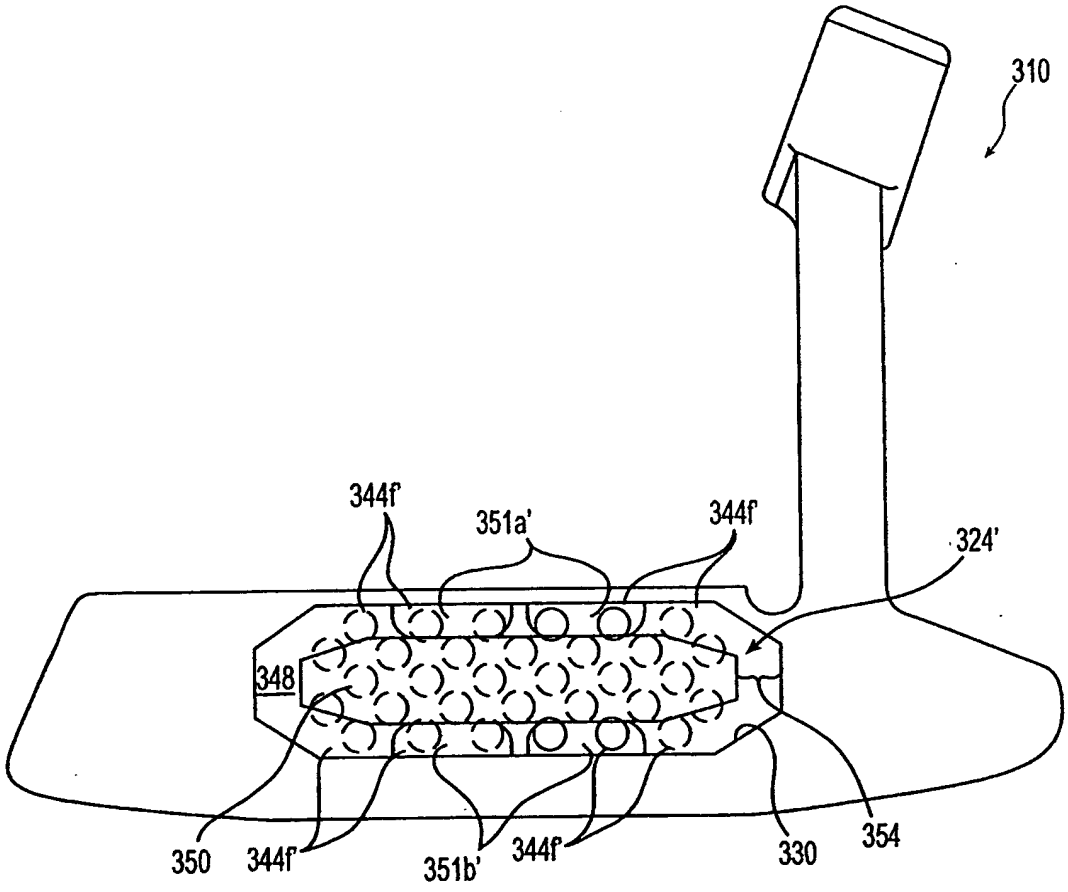


Fig. 32a

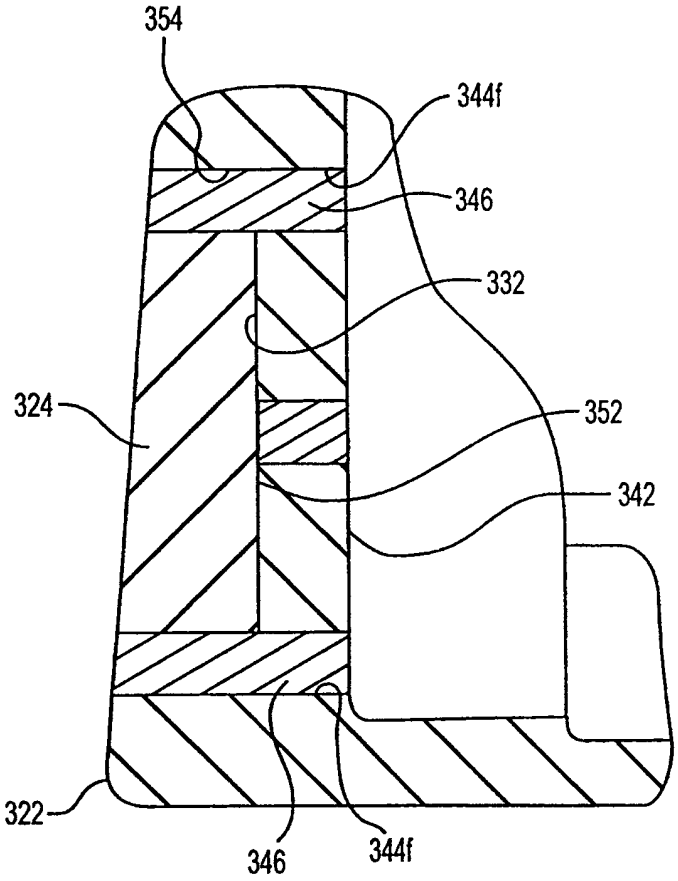


Fig. 33

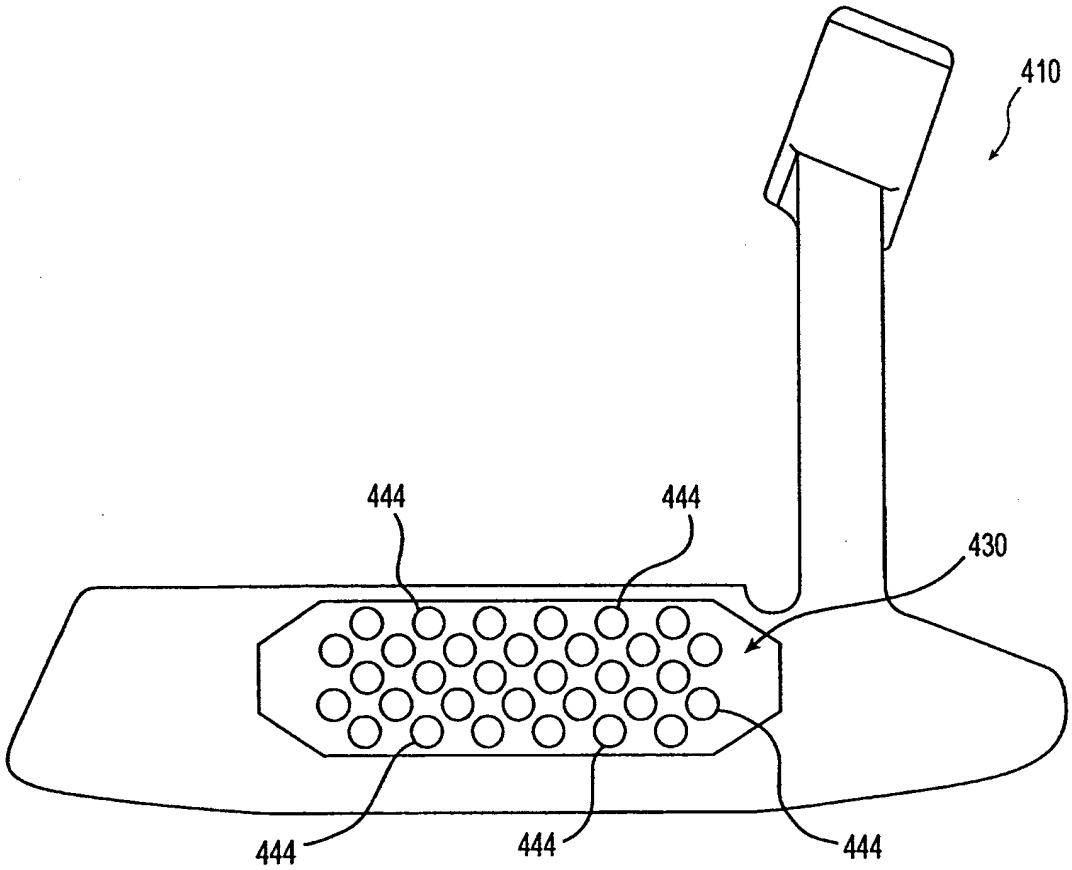


Fig. 34

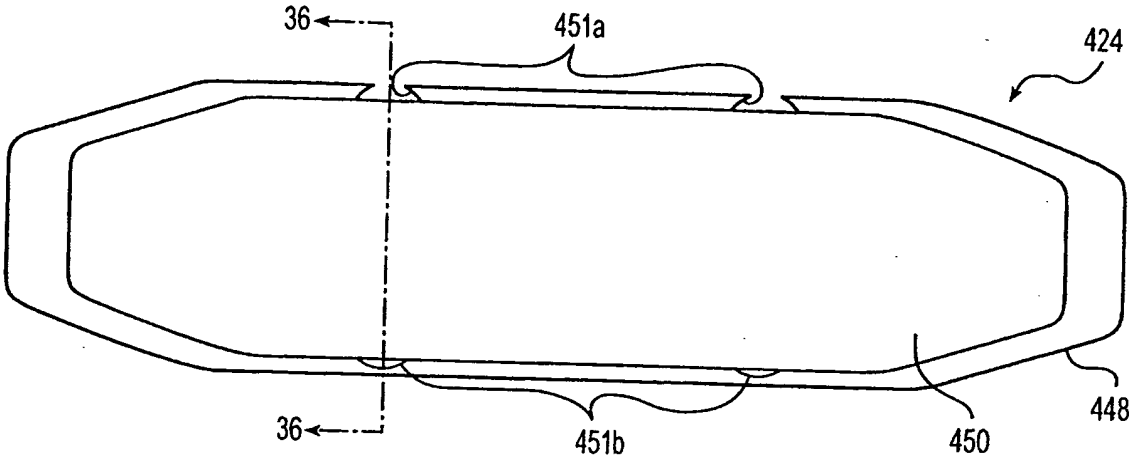
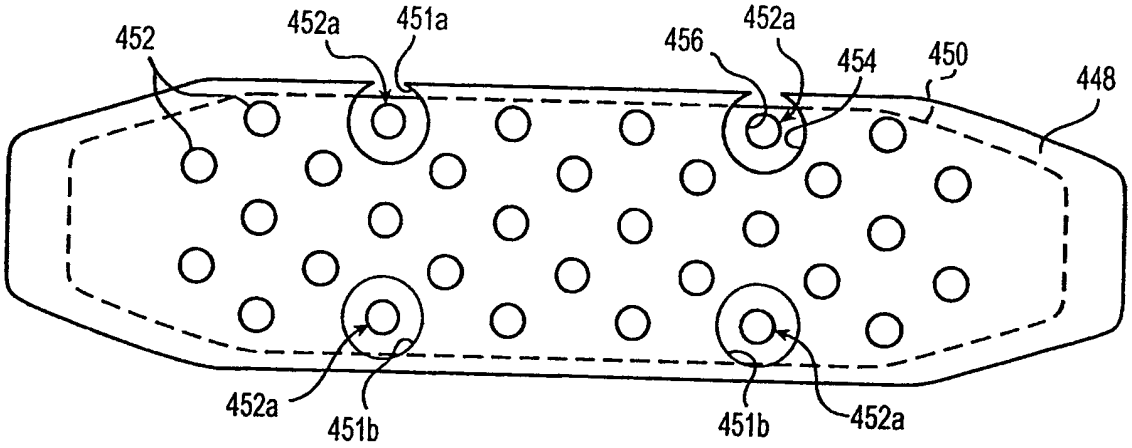


Fig. 34a



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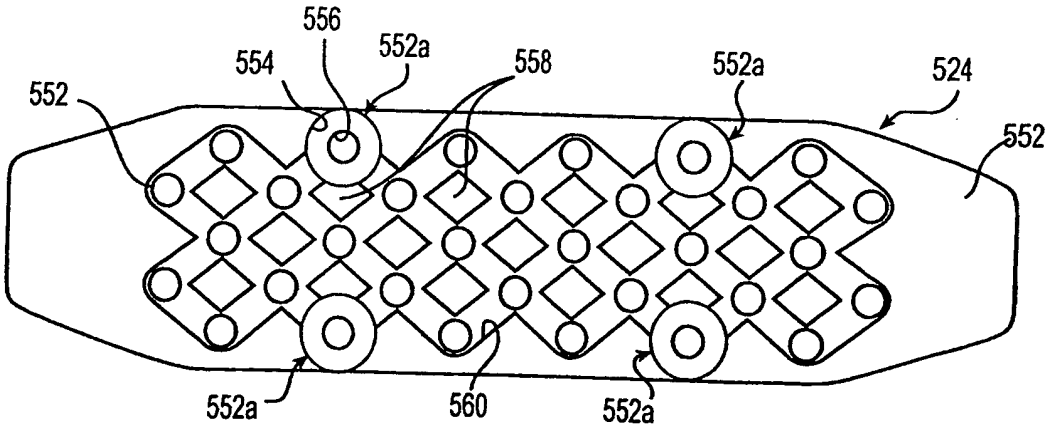

Fig. 37

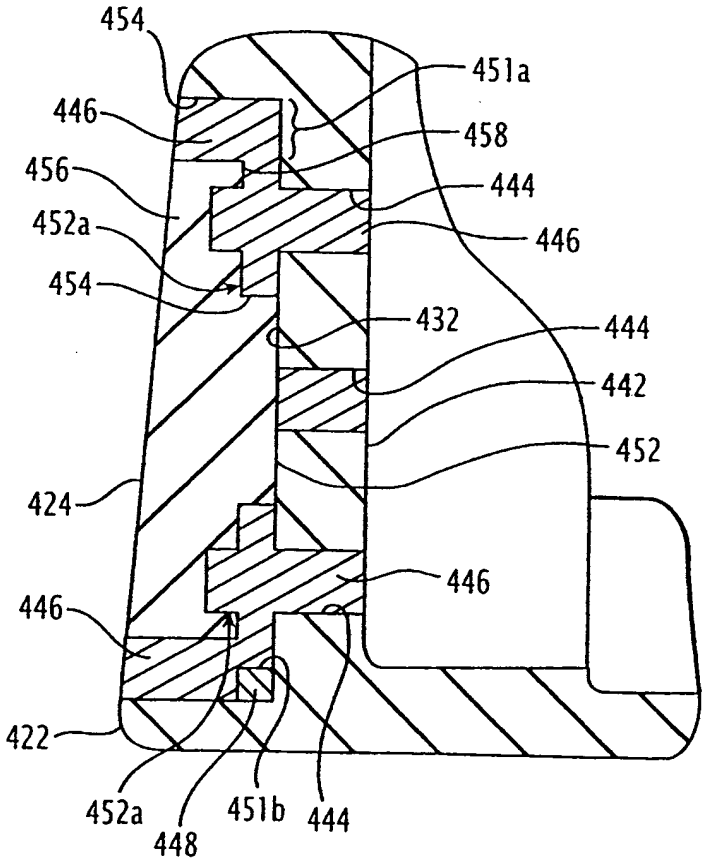
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Fig. 36

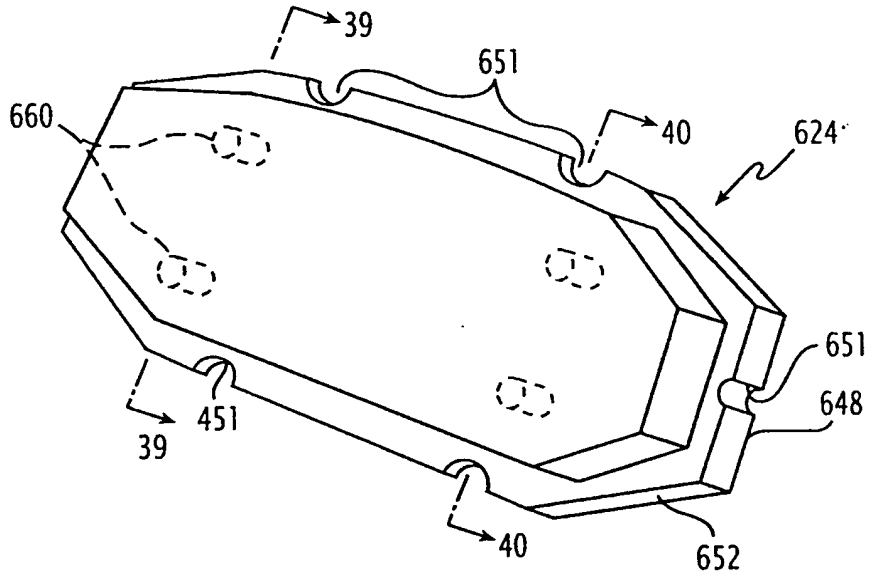

Fig. 38

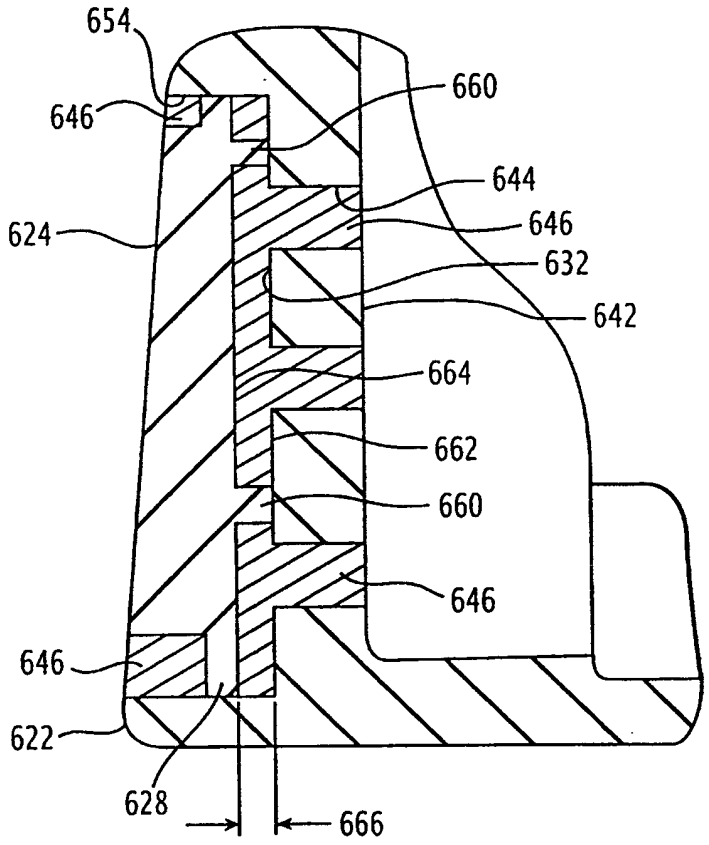

Fig. 39

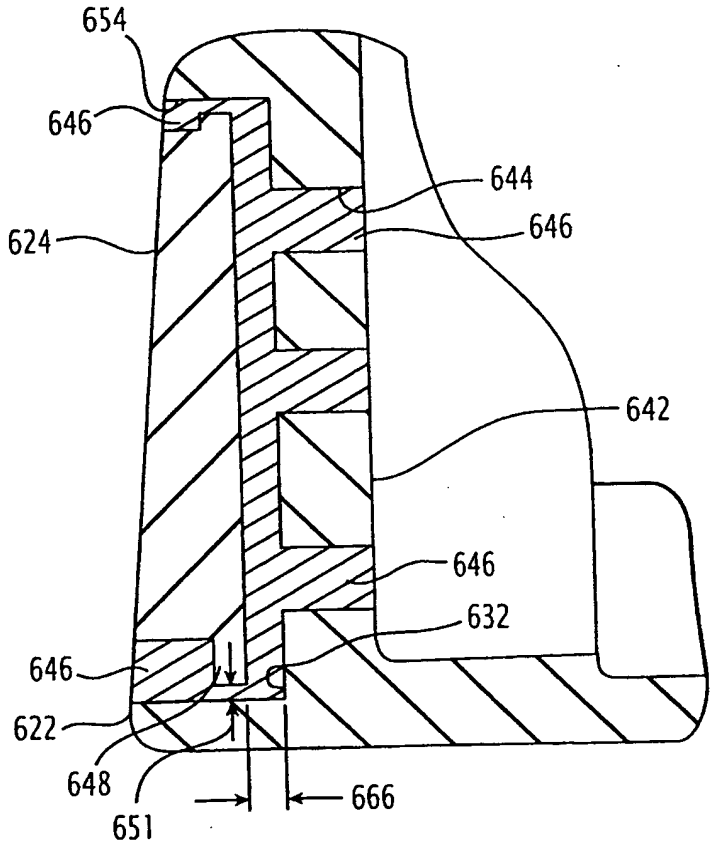

Fig. 40

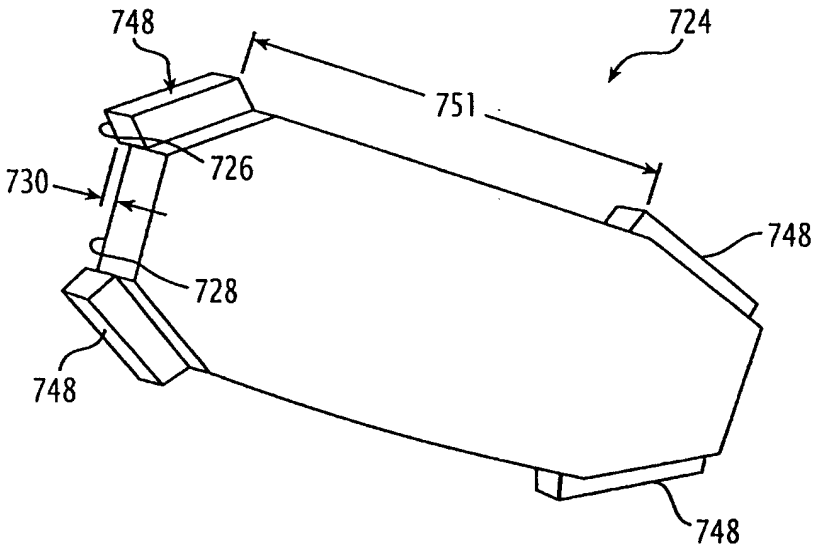

Fig. 41

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/30644

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :A63B 53/04
US CL : 473/324

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 473/324,332, 342

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,398,929 A **(KITAICHI)** 21 March 1995, See whole document.	1, 39, 40 --- 6, 8-15, 18
X --- Y	US 1,359,220 A **(BEAMER)** 16 November 1920, See whole document.	1-4 --- 16, 19, 22, 29
Y	US 2,034,936 A **(BARNHART)** 24 March 1936, See whole document.	6, 8-15, 18, 19
X --- Y	US 4,930 781 A **(ALLEN)** 05 June 1990, See whole document.	20, 21 --- 22, 29

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
09 MARCH 2000	21 MAR 2000

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